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ARTICLES

STUDIES ON PORTABLE JET AEROSOL GENERATORS FOR CONTROL OF ADULT MOSQUITOES [1]

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Veterinary and Medical Entomology Unit, Entomology Division, Ottawa, Canada

This study is an extension of tests already reported (Brown and Watson, 1953) for 5 machines used in mosquito control, whose emission rates range from 20 to 40 g.p.h. In this instance the generators tested are portable, and their emission rates range from 2 to 9 g.p.h. Determinations were made as before of the droplet spectra, of the amounts of the insecticide reaching various distances downwind, and of the effectiveness against adult *Aedes* mosquitoes in woodland at dosages similar to those employed with the larger machines.

MATERIALS. The following 2 machines were tested:

1. The Swingfog Pest Control Unit (Fig. 1), which is a portable aerosol generator that weighs 24 lb. empty and approximately 34 lb. filled. The aerosol is generated by a pulse-jet heater, operating at 80 pulsations per second, according to the Schwingfeuer system developed by Heizmotoren, G.m.b.H., Uberlingen, Bodensee, Germany. The type SN Swingfog machine built by that company is marketed by Devenco Inc., 150 Broadway, New York 38, N. Y., and is distributed in Canada by McDonald Bros. Equipment, Box 1019, Billings Bridge, Ottawa, Ontario. The fuel is gasoline, supplied from a tank holding 1 imp. qt. (1.2 U. S. qt.), sufficient for 1 hour's operation. The insecticide is contained in a tank holding 3.5 imp. qt. (4.2 U. S. qt.), and is pushed to an outlet nozzle under 6 p.s.i. air pressure tapped from the jet unit. Atomized from this nozzle, it enters a fog-mixing tube covering the outlet of the exhaust pipe. According to the manufacturer, the exhaust temperature is 400–450° C., and the temperature of the oil fog at the outlet is approximately 130° C.

2. The Dyna-Fog Jr. Jet Insecticidal Fog Generator (Fig. 2), a portable aerosol generator that weighs 15 lb. empty and 33 lb. filled. The aerosol is generated with the aid of a spring-steel flutter-valve, the pulse-jet operating at 83 pulsations per second. The machine is marketed by Curtis Automotive Devices Inc., Bedford, Indiana. The gasoline fuel is supplied from a tank holding 1.6 imp. qt. (1.9 U. S. qt.), sufficient for 55 minutes' operation. The insecticide is contained in a tank holding 1.5 imp. gal. (1.8 U. S. gal.), and is pushed by air pressure to the outlet nozzle in a fog-mixing tube. Ignition is provided by flashlight batteries incorporated in the Dyna-Fog Jr. machine, in contrast to the Swingfog apparatus which requires an automobile battery.

The tests with the Dyna-Fog Jr. machine were conducted at different openings of the insecticide regulating valve. The tests with the Swingfog apparatus were made with the insecticide regulating valve turned fully open; when emulsions were emitted, additional tests were made with the tap opened by one revolution

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[1] Contribution No. 3262, Entomology Division, Science Service, Department of Agriculture, Ottawa, Canada. The results herein reported were obtained by the Entomology Division in a program of studies on the biology and control of biting flies being carried out on behalf of the Defence Research Board, Canada Department of National Defence, and with the cooperation of that organization and other agencies.

[2] Head, Department of Zoology, University of Western Ontario, London, Canada; in the seasonal employ of the Entomology Division, as Entomologist, when this work was performed.

[3] Assistant Entomologist.

FIG. 1.—Swingfog units in action in woodland.

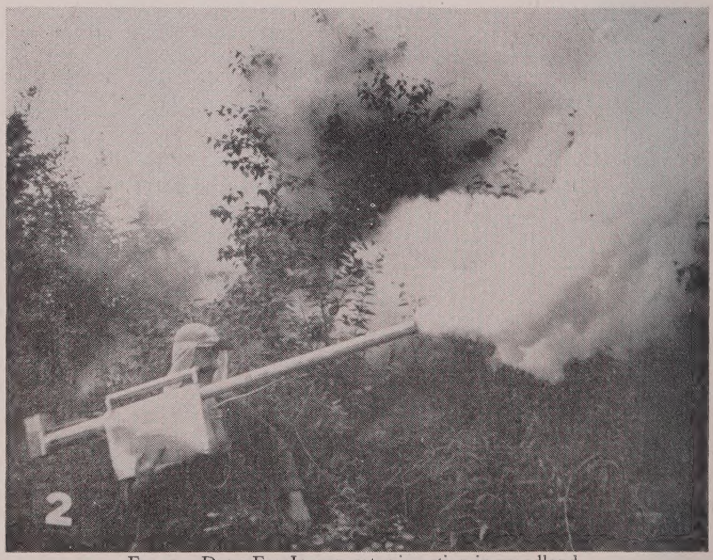

FIG. 2.—Dyna-Fog Jr. generator in action in woodland.

only. With this latter apparatus, two sets of orifices (at the regulating valve and at the outlet nozzle) were tested, one set being small and the other large, since they afforded two different emission rates of insecticide. The smaller orifices were originally supplied on the machine; the larger ones were drilled by the Canadian distributor (with a No. 60 and a No. 49 wire drill respectively) to increase the emission rate. The diameters, in inches, were as follows:

	Small	Large
Regulating valve	.028	.040
Outlet nozzle	.052	.075

The insecticide materials used in the tests were: (a) 5 per cent DDT solution in fuel oil (Shell Oil Co., Toronto, Ont.); (b) 30 per cent DDT concentrate in heavy aromatic oil (Sherwin-Williams Inc., Montreal, P. Q.); (c) 5 per cent DDT emulsion, made by adding 4 parts of water to 1 part of a 25 per cent emulsifiable concentrate (JP-25, John Powell Inc., New York, N. Y.); (d) 5 per cent DDT solution in kerosene (Shell Oil Co., Toronto, Ont.). All liquid volumes are quoted in this paper as imperial gallons (1 imp. gal. = 1.2 U. S. gal.).

METHODS. Emission rates were determined by putting a known quantity of liquid into the insecticide tank, and ascertaining the time required to expend it with the machine stationary; 3 to 5 determinations were made in each assessment for each formulation. Droplet spectra were assessed by drawing air samples, taken 6 ft. from the machine, through cascade impactors (Casella) at 17.5 litres per minute (Brown and Watson, 1953); with the Swingfog 4 or 5 determinations were made in each assessment, and with the Dyna-Fog Jr. a single determination was made from 3 cascade impactor samples taken. The droplet sizes are reported as mass median diameters (m.m.d.) computed by the method of Brown and Watson (1953), and in certain representative cases they are plotted as frequency distribution curves.

When the output of these machines was sampled at distances exceeding 50 yd., they were carried along an emission line 200 yd. long and at right angles to the wind. The amounts of DDT that reached various distances downwind were sampled with 9-inch squares of copper screening (Brown and Watson, 1953), and the material collected by them was analyzed by the Schechter-Haller method. Using two Swingfog machines, emitting 5 per cent solution, 0.35 lb. of DDT was applied per 100 yd. of frontage by covering the 200-yd. emission line in 28 minutes at a walking speed of 0.24 m.p.h. One such test was performed over open terrain, using the larger orifices emitting an aerosol whose m.m.d. approximated 15 microns; the wind speed was 6 m.p.h. and there was a very slight upward convection of the air. Six similar tests were performed on the passage of the aerosols through woodland. The oil solutions were tested at Camp Borden, in dense woods of white pine, jack pine, red pine, and poplar with much undergrowth; the emulsions were tested at Petawawa, in open stands of jack pine.

The effects of these aerosols on adult mosquitoes in woodland were investigated at Petawawa, Ontario, between June 9 and 18, with single additional tests performed at Goose Bay, Labrador, and Baie Comeau, P. Q. Specimens collected at Petawawa on June 15 and 16 were *Aedes trichurus* (Dyar), *A. punctor* (Kby.), *A. communis* (Deg.) and *A. intrudens* Dyar. The aerosols were applied at dosages between 0.22 and 0.36 lb. of DDT per 100 yd., from a front 200 yd. long. Tests conducted in the morning and afternoon required the wind speed (as measured in the open) to be 10–15 m.p.h. in order to penetrate the woods, whereas those in the evening were performed when the wind speed was approximately 5 m.p.h. Landing rates were taken at distances of 100, 200, 300, and 400 yd. before and 1 to 2 hr. after the application, by a crew of four men. The average landing rate before treatment, taken on the front of the trousers, was of the order of 15 per minute. Two treatments were compared in each field trial, in order to ascertain the percentage reduction in landing rate. The difference between the means of the 16 percentage reduction values for each pair of treatments was tested by Student's *t* test, the treatment variances not being considered the same and an arc sine transformation having been performed.*

$$*t = \frac{X_1 - X_2}{\sqrt{\frac{s_1^2 + s_2^2}{n-1}}}, \text{ where the variance } s^2 = \frac{\Sigma X^2 - \frac{(\Sigma X)^2}{n}}{n-1}.$$

In an attempt to ascertain the fate of mosquitoes exposed to the aerosol generated by the Swingfog emitting DDT (in 5 per cent solution in fuel oil) at 0.35 lb. per 100 yd., observers stood in the center of white linen sheets at 100, 200, and 300 yd. downwind of the line of emission. Landing rates were taken immediately before, during, and 5 minutes after the aerosol cloud had passed; observations were made on the behavior of the mosquitoes in their natural environment after the passage of the cloud; and at the 200-yd. point a number of specimens were collected, after the cloud had passed, and put individually into separate test-tubes stoppered with cotton wool.

The effects of these aerosols upon blackflies, principally *Simulium venustum* Say, were investigated at Baie Comeau, P. Q., between June 20 and August 8. The aerosols (in 5 per cent solution in fuel oil) were applied at dosages of 0.24 and 0.36 lb. per 100 yd. Landing rates were taken at the stated distances by a crew of four men, utilizing 18-inch squares of dark blue flannel, immediately before and 30 minutes after the treatment. In an attempt to ascertain the fate of blackflies exposed to the aerosol generated by the Swingfog emitting DDT (in 30 per cent concentrate) at 0.20 lb. per 100 yd. of frontage, observers stationed 25 yd. downwind took landing rates before, during, and after the passage of the cloud. Blackflies exposed to the passage of the cloud were immediately collected in sweep nets and transferred to battery jars wrapped in paper, and compared with blackflies simultaneously collected from an untreated area in acetone-cleaned sweep nets and transferred to battery jars which were kept in that area.

RESULTS. The delivery rates and droplet sizes produced by the Swingfog apparatus under various conditions are shown in Table 1. The average emission rate with 5 per cent DDT solution through the original small orifices was 1.5 g.p.h. The use of the larger orifices about doubled the emission rate. The rates obtained were consistent when 5 per cent solution was used, but variable with the 30 per cent concentrate. The rates were very variable with the 5 per cent emulsion, especially when the regulating valve was fully open; in addition, short stoppages occasionally developed, caused by clots (resulting from a "ropy" emulsion) collecting mainly in the insecticide shut-off tap. When the insecticide regulating valve was opened by only 1 turn, the emission rate of the emulsion through the small orifices was slightly reduced but more consistent. With the oil solution and oil concentrate emitted through the small orifices, the emission rate with the valve opened by only 1 turn was no less than when it was fully opened. When the large orifices were used, opening the valve by only 1 turn restricted the emission to 36 per cent of the rate when the valve was fully opened.

The droplet sizes of the aerosols produced by the Swingfog from 5 per cent DDT solutions were represented by average mass median diameters of 11.0 microns for the small orifices and 15.2 microns for the large orifices (Table 1). The droplets obtained with the 30 per cent concentrate were slightly coarser. With both oil solutions, there was no fall-out of coarse droplets (except an occasional 50-micron droplet) immediately in front of the machine; the spray atomized from the outlet nozzle did not impinge on the inside of the fog-mixing tube. With the 5 per cent emulsion emitted through the large orifices, a coarse aerosol of 27 microns m.m.d. offset the advantage of the higher emission rate of 3.1 g.p.h. The initial spray impinged on the fog tube, and a considerable amount of coarse re-atomization took place from the edges of the tube. With the smaller orifices a finer aerosol was produced from the emulsion, but there was still some impingement on the tube; if, however, the regulating valve was opened by only 1 turn, a fine aerosol of 8 microns m.m.d. was obtained at an emission rate of 1.7 g.p.h. This fine degree of atomization is remarkable in view of the fact that the temperature at the end of the outlet pipe under condi-

TABLE 1.—Swingfog: emission rates and droplet sizes with various formulations of DDT and adjustments in the apparatus

Formulation and adjustment	Emission rate, g.p.h. Average	Emission rate, g.p.h. Range	Mass median diameter, microns Average	Mass median diameter, microns Range
5% Solution				
Small orifice	1.51	1.40–1.64	10.9	8.6–15.9
Large orifice	3.34	2.23–3.45	15.2	10.2–18.1
30% Concentrate				
Small orifice	1.35	1.10–1.53	11.8	8.6–16.8
Large orifice	2.73	2.50–2.96	18.7	13.0–23.0
5% Emulsion				
Small orifice	2.07	1.54–2.58	16.3	12.8–20.4
Small orifice*	1.70	1.53–1.82	7.8	6.5– 9.1
Large orifice	3.10	2.58–4.80	26.9	18.2–25.0

* Insecticide regulating valve opened by only 1 turn.

tions similar to these is only 65° C. (Cooper Technical Bureau, unpublished report).

The frequency distribution curves of representative droplet spectra are shown in Fig. 3. The curve for the 5 per cent solution was characterized by an extension into the larger droplet sizes. The frequencies for 30 per cent concentrate, and for the 5 per cent emulsion with the valve opened 1 turn, were closely distributed about the mean. When 5 per cent solutions were emitted through large orifices, or 5 per cent emulsions through a fully opened valve, the frequency curve showed a "tail" extending into the large droplet sizes.

The delivery rates and droplet sizes produced by the Dyna-Fog Jr. generator under various conditions are shown in Table 2. Although the machine was capable of emitting 5 per cent DDT solution in fuel oil at 9 g.p.h. with the regulating valve fully open, the atomization was too coarse. When the valve was opened only 3.5 turns (not quite half open), a satisfactory droplet spectrum of 18.5 microns m.m.d. was obtained at an emission rate of 6 g.p.h. The same opening of the valve gave a suitable droplet spectrum with the 30 per cent concentrate at an emission rate of approximately 5 g.p.h. Although it would appear from Table 2 that the 5 per cent solution in kerosene gave a satisfactory droplet size when emitted at full opening, the figure of 15.4

TABLE 2.—Dyna-Fog Jr.: emission rates and droplet sizes with various formulations of DDT and adjustments in the apparatus

	Valve setting, no. of turns from closure				
	3	3.5	4	6	8.5
5% DDT in fuel oil					
Emission rate, g.p.h.	4.6	6.0	7.3	8.6	9.0
Mass median diameter, microns	8.2	18.5	56	78	...
5% DDT in kerosene					
Emission rate, g.p.h.	4.8	5.6	7.8	...	8.9
Mass median diameter, microns	8.9	8.8	12.8	...	15.4
30% DDT concentrate					
Emission rate, g.p.h.	1.7	4.8	5.2	6.8	6.9
Mass median diameter, microns	9.0	11.5	4.1	36	55
5% DDT emulsion					
Emission rate, g.p.h.	3.5	...	6.0	...	...
Mass median diameter, microns	130	...	82	...	...

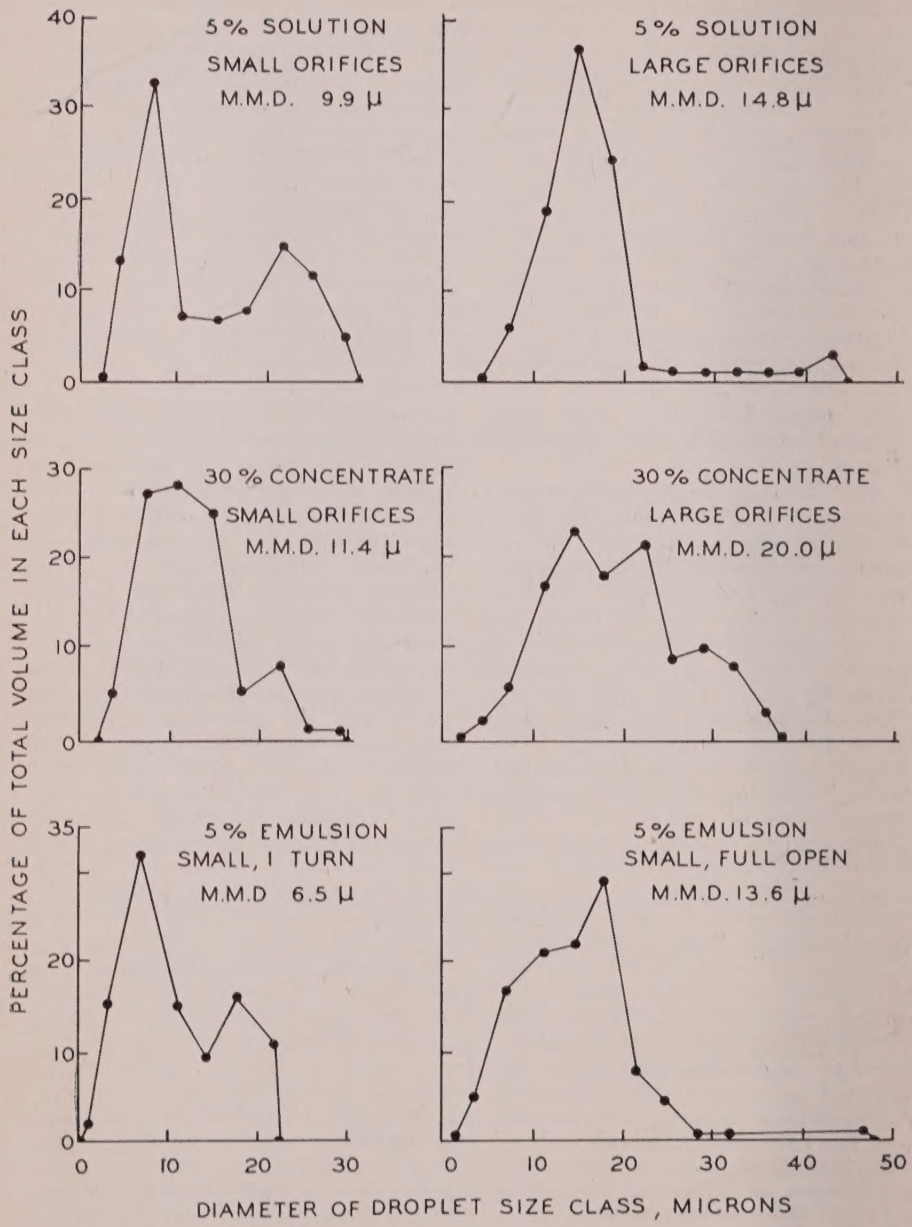

FIG. 3.—Frequency distributions of droplet sizes of aerosols produced by the Swingfog unit from various formulations.

microns for the m.m.d. is misleading since the large droplets in the spectrum were counterbalanced by an excessive amount of extremely small droplets. A droplet spectrum of aerosol size could not be obtained with emulsions, due to impingement on the fog-mixing tube, and progressive reduction in delivery rate if the regulating valve was opened only slightly. As may be seen from Fig. 4, the frequency distribution of droplet sizes from the Dyna-Fog Jr. dispersal system lay in the vicinity of 10 microns; larger m.m.d. values were caused by the appearance of a "tail" consisting of a comparatively small number, but a large aggregate volume, of droplets above aerosol size.

When an aerosol cloud of 15 microns m.m.d. was emitted from the Swingfog over open terrain by the method described

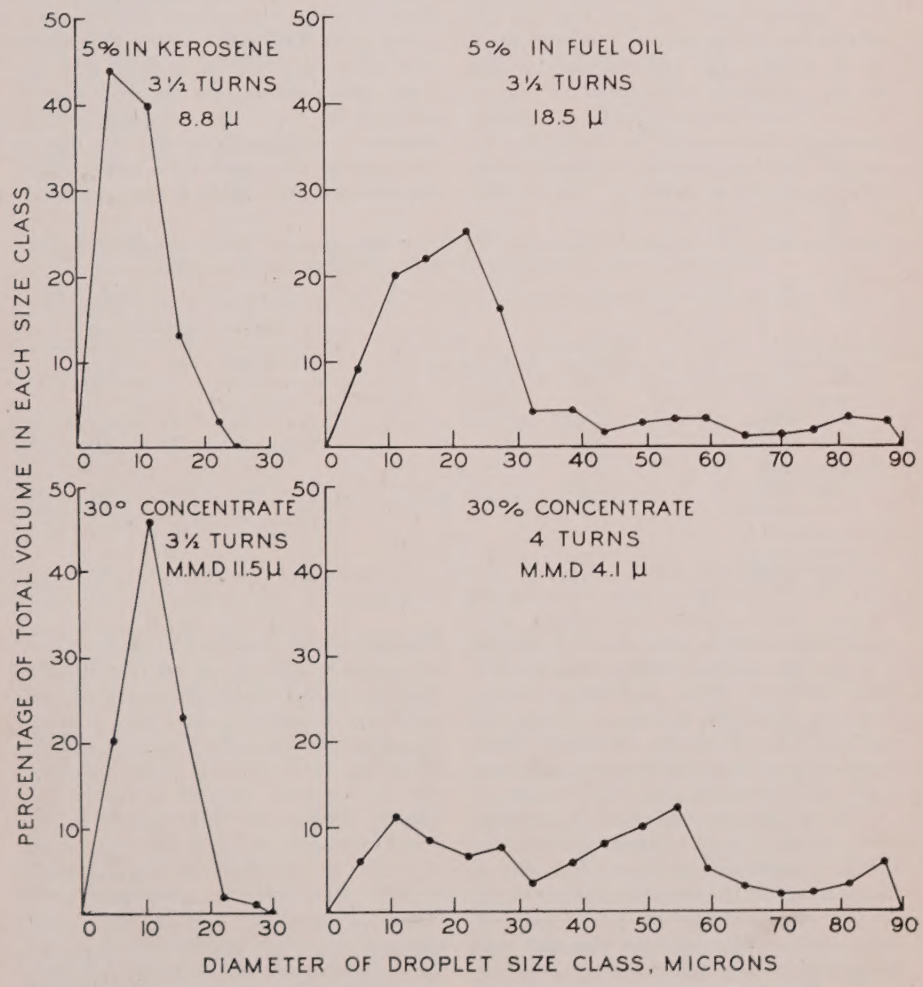

Fig. 4.—Frequency distributions of droplet sizes of aerosols produced by the Dyna-Fog Jr. generator from various formulations.

above, the following droplet sizes and DDT recoveries on 81-sq. in. copper screens were obtained:

Distance downwind, yards	50	100	200	300	400
DDT on screens, micrograms	369	200	205	140	158
Mass median diameter, microns	4.8	7.6	3.8	3.9	4.0

The largest droplets to reach the 50- and 100-yd. points were 12.5 microns in diameter; at the 200-, 300-, and 400-yd. points, 7 microns. At the point of emission, approximately 20 per cent of the volume was in the form of 7-micron droplets or smaller, and approximately 30 per cent as 12.5 microns or smaller.

The recoveries of DDT at various distances downwind of the Swingfog apparatus emitting aerosols through woodland are shown in Table 3. The oil solutions maintained a good level of dosage for 400 yd. when emitted through the small orifices. With the large orifices, however, there was a drop in dosage beyond 50 yd. With the emulsions there was a marked drop in dosage to inadequate levels at distances of more than 100 yd.

The percentage reductions in landing rates of adult *Aedes* obtained with the different treatments are shown in Table 4. The average of the reductions obtained up to 400 yd. downwind in the 11 pairs of tests, with dosages between 0.24 and 0.46 lb. per 100 yd., was 72.7 per cent. When the Swingfog apparatus was operated with the regulating valve fully open, and with the large orifices, the 5 per cent solution in fuel oil was superior to the 5 per cent emulsion, the difference between the results of the two treatments being significant at the 1 per cent level; with the small orifices, the difference between the treatments was not statistically significant. If the emulsion was emitted with the regulating valve open only 1 turn, the results were in no way inferior to those with the 5 per cent solution; the apparent superiority of the 5 per cent emulsion in this instance is attributable to the fact that it was emitted over more open terrain than the solution with which it was compared.

TABLE 3.—Recoveries (single determinations) of DDT, in micrograms, at various distances downwind of emission of various formulations from Swingfog unit through woodland

Formulation and orifices	DDT emitted per 100 yd., lb.	Wind m.p.h.	Distance downwind, yards 50	100	200	300	400
5% solution							
Small orifices	0.346	4	75	64	27	119	194
Large orifices	0.346	6	207	93	44	66	61
30% concentrate							
Small orifices	0.340	4	424	224	242	224	462
Large orifices	0.345	3	205	56	56	124	206
5% emulsion							
Small orifices	0.340	3	30	6	26	54	2
Large orifices	0.536	3	138	226	14	42	48

The differences in reduction by the 5 per cent solution and the 30 per cent concentrate at parallel DDT dosages were not significant at the 5 per cent level. A single comparison between the Swingfog and the Dyna-Fog, both emitting 5 per cent solution in kerosene, showed a highly significant difference. Unfortunately it was found impossible to repeat this comparison in order to establish whether kerosene solutions were definitely unsuitable in the Dyna-Fog generator. With the 5 per cent solution in fuel oil, the Swingfog with the original small orifice was as effective, at parallel DDT dosages, as the TIFA operated at 1,000° F. and 19 g.p.h.; the

Table 4.—Percentage reductions (averages of 4 counts) in landing rates after application of various formulations of DDT with Swingfog, Dyna-Fog Jr., and TIFA machines against *Aedes* mosquitoes in eastern Canadian woodland

DDT formulation	Orifices or machines	DDT emitted per 100 yd., lb.	Woodland type	Reduction, %, at yd. downwind 100	200	300	400	average
Swingfog: solution versus emulsion								
5% solution	Small	0.30	Thick	85	51	58	53	62
5% emulsion	"	0.30	Mixed	81	67	33	23	51
5% solution	Large	0.36	Thick	98	87	85	92	91
5% emulsion	"	0.32	Mixed	99	59	55	58	68
5% solution	Small	0.22	Spruce	91	100	88	67	86
5% emulsion*	"	0.22	Woods	100	100	95	86	95
Swingfog: solution versus concentrate								
5% solution	Small	0.24	Open	91	100	95	90	94
30% concentrate	"	0.24	Pine	80	91	83	64	80
5% solution	Small	0.35	Thick	82	99	42	72	74
30% concentrate	"	0.46	Mixed	94	66	81	40	70
Swingfog: small orifices versus large								
5% solution	Small	0.24	Thick	62	66	88	73	72
5% solution	Large	0.24	Mixed	87	60	33	73	63
5% solution	Small	0.24	Thick	95	100	71	75	85
5% solution	Large	0.24	Mixed	83	91	82	73	82
Swingfog (small orifice) versus Dyna-Fog Jr. (3½ turns)†								
5% in kerosene	Swingfog	0.36	Thick	94	99	97	99	97
5% in kerosene	Dyna-Fog	0.36	Mixed	90	76	22	21	52
Swingfog (small orifice) versus TIFA								
5% solution	Swingfog	0.35	High	100	92	63	76	83
5% solution	TIFA	0.35	Pine	100	78	84	89	88
5% solution	Swingfog	0.35	Pine	75	0	0	34	27
5% solution	TIFA	0.32	Undergrowth	22	72	70	68	58
5% solution	Swingfog	0.30	Thick	100	83	51	51	71
5% solution	TIFA	0.28	Mixed	78	70	35	19	51

* Regulating valve open only 1 turn; test performed at Goose Bay, Labrador.
† Test performed at Baie Comeau, Que.

variation in the last two experiments is attributable to differences in woodland density between the two plots.

The landing rates of mosquitoes taken by observers stationed at various distances downwind in woodland during the passage of a DDT aerosol emitted from the Swingfog at 0.35 lb. per 100 yd. were as follows:

	100 yd.	200 yd.	300 yd.
Before passage	8	37	18
During passage	0	21	10
5 min. after passage	0	7	2

As the aerosol cloud passed, the mosquitoes became excessively active and avoided landing on the observers, especially at the 100-yd. point. Three minutes after the passage of the cloud, many disappeared from the air around the observers, the disappearance being total at the 100-yd. point. Many took refuge on the undersurfaces of leaves such as those of alder. At the 100-yd. point, some walked stiffly on the forest floor. One of these was observed continuously; after cleaning her proboscis with the prothoracic legs for 30 min., she showed periodic spasms that lifted her from a crouched position and finally turned her on her back, to die 1 hr. after the passage of the cloud. At the 200- and 300-yd. points, affected mosquitoes alighted, performed cleaning movements, and flew on. Of eight specimens collected into test tubes at the 200-yd. point, three showed toxic symptoms 2.5 hr. later, one dying 5 hr. and two 7 hr. after exposure, rolling and tumbling

in the final stages of poisoning; the other five remained normal.

A total of 10 tests were performed to determine the percentage reductions in landing rates of *Simulium* adults obtained 20 to 50 minutes after the passage of a cloud of DDT in oil solution emitted through woodland. The results were extremely variable, ranging from no reduction to 77 per cent reduction. The percentage reductions obtained at the various distances downwind in 5 tests performed at the highest dosage, which was 0.36 lb. per 100 yd., were as follows:

100 yd.		200 yd.		300 yd.		400 yd.		Average	
Range	Av.	Range	Av.	Range	Av.	Range	Av.	Range	Av.
3–97	55	0–75	15	0–82	31	0–61	23	1–77	31

Eight of these tests involved a paired comparison between the Swingfog and the Dyna-Fog Jr. at the same dosage of DDT and approximately the same m.m.d. of the droplet spectra. In 3 of these 4 paired comparisons, the Swingfog gave the greater reduction in landing rate.

The average landing rates of blackflies taken by 2 observers stationed 25 yd. downwind in woodland during the passage of a DDT aerosol emitted from the Swingfog at 0.20 lb. per 100 yd. were as follows:

Time from passage, min.	−8	−5	−2	+1	+4	+7	+10	+13
Average landing rate	121	92	149	39	15	45	92	102

The reduction in landing rate in the 10 minutes after the passage of the cloud was observed to be due to the blackflies scattering from the observer and sheltering in foliage.

When blackflies were collected from a treated area and held for observation in battery jars, the following results were obtained on comparing the collections from 3 treated areas with one from an untreated area 3 hours after they were collected:

	Normal	Affected	Dead
Treatment 1	0	17	5
Treatment 2	0	37	0
Treatment 3	0	11	1
Control	17	2	0

All the flies exposed to the aerosols exhibited ataxia in walking movements 1 hr. after exposure. All flies exposed to the aerosols were dead 11 hr. after exposure, at which time all the unexposed flies were still living, although the majority had become motionless.

DISCUSSION. These experiments show that the Swingfog apparatus can emit aerosols that are suitable for controlling woodland mosquitoes. These aerosols have finer droplets than those usually emitted by the TIFA machine. Although the droplet spectrum with fuel oil is bimodal, which bimodality had also been observed by Dr. H. Geffeken, Monthey, Switzerland (personal communication to Devenco Inc., 22 April 1953), it is more compact and consistent than from the other portable jet generator, the Dyna-Fog Jr.; this latter machine characteristically produces a large amount of smoke-size droplets less than 1 micron in diameter, as was noted also for the large Dyna-Fog generator (Brown and Watson, 1953). The Swingfog apparatus is simple to operate and gives little trouble; during a total of 50 hours' running time, there were only three instances of fire in the fog-mixing tube, resulting from ignition of the DDT solution. The apparatus is portable, but at parallel dosages it gives control equal to that obtained with the TIFA, which requires a vehicle and roads. Nevertheless, the low emission rate of 1.5 g.p.h. with the original small orifices is a handicap for the use of the Swingfog in Canadian woodland. For this reason, the use of the substitute larger orifices to double the emission rate is probably economical, despite the slight decrease in control per pound of DDT emitted. Where speed of treatment is important, the 30 per cent concentrate may be substituted for the 5 per cent solution. The greater

emission rate of the Dyna-Fog Jr., which is 3 to 4 times that of the Swingfog as supplied, is a distinct advantage for this generator. Whereas the Swingfog requires an automobile battery for initial ignition, the Dyna-Fog Jr. has a built-in ignition system. However, the lighter construction of the Dyna-Fog Jr. generator makes it less suitable for use under rough conditions in the woods.

Under normal conditions it is more satisfactory to use DDT solutions rather than emulsions, principally because there is no operating difficulty with the former since the insecticide lines remain clear. However, when there is fire hazard in the woods, or where because of transport difficulties only DDT emulsifiable concentrate and no diluent is available, emulsions may be used in the Swingfog but not in the Dyna-Fog Jr. The cloud produced by the Swingfog from emulsions is not spectacular, and its delivery is subject to irregularities and stoppages, but it gives excellent control. These findings are in agreement with those of the Cooper Technical Bureau (unpublished report) that better control of adult house flies may be obtained with emulsions (12.5 per cent DDT, or pyrethrins plus piperonyl butoxide) than with solutions of parallel concentration, provided that the emulsion is emitted with only one-half or one turn of the regulating valve so that no excess liquid impinges on the fog-mixing tube. In tests conducted in Nigeria against adults of *Aedes aegypti* L. in native houses, Elliott and Fitz-John (1953) found that DDT emulsions were no less effective than solutions, but that the relative invisibility of the cloud made it difficult for semi-skilled operators to make the correct application.

The observations made on the fate of mosquitoes exposed to the aerosols do not support the suggestion, arising from work in Alaska by McDuffie *et al.* (1950), that mosquitoes affected by aerosols move to ground level and then return to progressively higher levels. When the dosage of DDT was low and therefore slow in action, the mosquitoes responded instead by seeking secluded spots to rest. Those that still came to man showed no increased preference for the ankles as against the upper parts, although many of them were either excessively active or torpid, depending on the stage of poisoning reached. Of those mosquitoes that land on man after the cloud's passage, a portion are probably due to die within approximately 6 hours, as indicated by these observations.

The results obtained by the application of these aerosols against blackflies were comparable to those reported by Travis (1949) from Alaska, who noted little reduction in numbers immediately after treatment and considered that this was due to the rapidity of infiltration from surrounding areas. Certainly the control obtained with aerosols was not as great as the reduction of 80 to 87 per cent observed after aerial spraying with 10 to 20 per cent DDT in oil solution (Brown, 1952). Although the experiments here reported indicate that DDT aerosols at 0.16 to 0.36 lb. per 100 yd. of frontage eventually kill, or at least hasten the death of, adult blackflies, it is evident that the dosage is insufficient (as suggested by Travis) to kill them within a short space of time. Translated in terms of experience, the application of aerosols at dosages suitable for mosquito control may be expected to achieve on the average a one-third reduction in landing rate of blackflies, assessments of which may range from three-quarters reduction to no reduction at all.

Summary. In producing aerosols for control of adult *Aedes* mosquitoes, the Swingfog portable jet apparatus emitted 5 per cent DDT in fuel oil at 1.5 g.p.h., the droplet spectrum having a mass median diameter of 11 microns. With 30 per cent concentrate the emission rate was 1.4 g.p.h. and the m.m.d. 12 microns. With 5 per cent emulsion the rate averaged 2.1 g.p.h. and the m.m.d. 16 microns; when the regulating valve was opened by only 1 turn, the emission rate was 1.7 g.p.h. and the m.m.d. 8 microns. An increase of approximately 50 per cent in

orifice size about doubled the emission rates and increased the droplet sizes by approximately 60 per cent.

When DDT aerosols were emitted at dosages between 0.22 and 0.36 lb. per 100 yd. of frontage, the reduction in landing rate of mosquitoes for 400 yd. downwind averaged 73 per cent, the average reduction in any one test ranging from 27 to 97 per cent. At parallel DDT dosages, the differences in the reductions in landing rates from the 5 per cent solution and the 30 per cent concentrate were not statistically significant. Results with the 5 per cent emulsion were significantly inferior to those with the solution when emitted at full volume, but when the regulating valve was opened by only 1 turn the results were not inferior. At parallel DDT dosages, the 5 per cent solution emitted from the Swingfog apparatus gave as good reduction as when emitted from the TIFA machine, although a much longer time was consumed in application.

The Dyna-Fog Jr. portable jet generator emitted 5 per cent DDT in fuel oil at 6.0 g.p.h., the droplet spectrum having a m.m.d. of 18.5 microns, if the regulating valve was opened by 3.5 turns. At this setting it emitted 30 per cent DDT concentrate at 4.8 g.p.h. with a m.m.d. of 11.5 microns. With 5 per cent emulsion the droplets were too large and the emission rate progressively decreased.

At dosages of 0.36 lb. DDT per 100 yd. of frontage, aerosols from these jet generators achieved reductions of landing rates of adult *Simulium* blackflies that averaged 31 per cent for 400 yd. downwind. However, the average reductions in any one test ranged from 1 to 77 per cent.

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Erratum

In the description of the Alaska Aerosol Atomizer in the paper by Brown and Mulhern, in Volume 14, No. 4 (December, 1954), the first sentence of column 2, p. 185 should read ". . . a 0.63 mm. tip emits the insecticide opposite a 1.95 mm. air orifice" instead of 2.7 mm. and 5.4 mm. respectively as originally stated.—A. W. A. Brown.

NOTES ON *CULICOIDES FURENS* (POEY) AT FORT KOBBE, CANAL ZONE

FRANKLIN S. BLANTON,[1] OWEN H. GRAHAM[2] AND CHARLES M. KEENAN[3]

For a great many years *Culicoides furens* (Poey) has been very troublesome at certain Army installations and civilian communities on both the Atlantic and Pacific slopes of the Canal Zone in Panama. The writers have observed and studied this condition at Fort Kobbe and the breeding areas adjacent to this installation. This same area was studied by Carpenter, whose observations were published in 1951. Subsequent investigations, which are reported in this paper, were a continuation of Carpenter's works with additional emphasis placed on the control aspects of the problem.

Culicoides as Vectors of Disease. A number of authors have incriminated various species of *Culicoides* and other biting Heleidae as vectors of the causative organism of several diseases, Buckley (1933–34) (1938); Causey (1938); Dutoit (1944); Sasegham (1918); Sharp (1927–1928); Steward (1933); and Wilcocks (1917). The writers have had no experience with transmission studies with *Culicoides* as disease vectors. In all probability there are a number of species which are capable of acting as vectors of filarial worms and other pathogens. Certain species of *Culicoides* are so abundant and widely distributed that their potentialities as vectors should be investigated.

Effects of *Culicoides* Bites. Large populations of *Culicoides,* such as are found at several places in Panama and such as the senior author saw in Valdez, Alaska, can be so annoying as to be almost unbearable. These biting gnats are voracious feeders, undeterred by all reasonable attempts of the unwilling host to protect himself. They easily pass through the mesh of ordinary window screens, bed nets and head nets, and will bite through any clothing which is light enough to be comfortable in the tropics. Repellents have been almost useless, giving only very temporary relief.

Individual sensitivity to these bites is variable, but during the periods of peak adult populations, it is quite common for women and children to request medical treatment for secondary infections resulting from sandfly bites. The bare legs of women and children are bitten to a greater extent than the legs of men which are ordinarily protected by clothing. Also, it appears that newly arrived Caucasians react more violently to multiple bites than do long time residents of the Canal Zone and Panama. The characteristic lesions and inflammation which result when sensitive persons are exposed to large numbers of *Culicoides* are locally known as "Kobbe leg" because of the high incidence among newly arrived dependents residing at that Army post.

Species Complex. When the senior writer began work in Panama (1951) there were twelve species of *Culicoides* reported from Panama. Extensive surveys throughout the entire road system of this country have revealed a great many more species (Wirth and Blanton, 1953). Fort Kobbe has an almost pure colony of *Culicoides furens.* This has been a great time saver as the taxonomic difficulties encountered in separating Panama species would retard the work had any other area known to the writers been selected for study.

Fort Kobbe is situated on the west side of the Pacific entrance to the Panama Canal. Although the terrain is dominated by numerous steep hills there are several salt marshes on two sides of the post. The largest of these marshes is the Farfam Swamp which lies on the NE side of the

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post. This swamp, approximately 2,200 acres in size, is used by the Dredging Division of the Panama Canal Company as a disposal area for the spoil from hydraulic dredging operations. Although separated from the bay by a dike, this area was subjected to tidal inundations prior to 1950. Most of the swamp was covered during the time of the monthly high tides which, at this location, are often in excess of 18 feet. As a result of this periodic flooding with salt water the area was bare of vegetation and the soil was highly saline. The work of Woke (1954) in this and similar areas demonstrated that *Culicoides* larvae are extremely abundant in the zones which are flooded by the few extremely high tides which occur each month but which are too high to be flooded daily.

In August 1950, as a result of the efforts of R. E. Fontaine, W. D. Reed, Stanley Carpenter, John P. Smith, and others, tidegates were installed in the spillway structure so as to exclude seawater from the swamp. It was expected that the long term result of this installation would be the conversion of the salt water swamp to a fresh water swamp as the rainfall was estimated to be heavy enough to leach all the salt out of the swamp in a few years' time.

LARVAL STUDIES. *Methods.* Carpenter (1951) tried out the techniques for determining larval incidence used by Painter (1934), Dove *et al.,* (1932), and Hill (1947). After trying several methods he sampled larval populations by collecting about 400 cc. of mud from known locations, and placing this mud sample in wide mouthed jars. The jars were given a number, carried to the laboratory and flooded with tap water, and allowed to stand overnight. The following morning the water which accumulated on top of the sediment was gently agitated and drawn off with a pipette. Counts were based on the number of larvae found in six syracuse watch glasses examined with low power microscope. This same method was used by the 25th Medical Detachment for obtaining the larval counts reported in this paper.

Carpenter established 552 definite locations near Fort Kobbe which were positive for larvae at one or more times during the wet season of 1950—(June-December). These collecting stations remained positive until the onset of the dry season. Since 1950 the ecological picture has changed drastically. Prior to the installation of tidegates, the swamp was so boggy that it was almost impossible to walk anywhere except along established trails. Vegetation was very sparse with many large bare areas scattered throughout the swamps. Most of these areas are now dry and overgrown with a dense stand of mangrove 10 to 15 feet high. These ecological changes have affected the larval population immensely. The relative importance of these changes is difficult to assess, but the combined effect of dryness, reduced salinity and increased shade has resulted in reduced numbers of larvae. Woke (1954), Carpenter (1951), and the writers have found larvae in shaded areas, but only rarely. In January 1952 larvae were found only along the water's edge on the banks of the Farfan River. Of 98 samples tested in September 1952, only one was positive and only one larva was found. This is a contrast from former samples, many of which had 500 or more larvae.

Larval sampling was continued periodically through the years 1951 to 1954. During the years of 1952 and the first half of 1953 it was very difficult to find any larvae and the large numbers observed before the tidegates were installed are still conspicuously absent. Because of the extremely low population which prevailed in 1952 and 1953, no attempt was made to sample all the stations established by Carpenter, but random samples were consistently negative. Not only did the control measures cause a satisfactory reduction in the numbers of larvae but also a change in the larval habitat.

ADULT STUDIES. *Methods.* The same method as reported by Carpenter (1951),

for measuring population densities has been continued. In fact, some of the horse-baited traps as employed by Carpenter are still in the same location. Sheets of white bond paper (8 x 10½ inches) were treated with castor oil on one side and mounted on plywood boards. These were set in upright position in a horse-baited trap and left overnight.

The adult *Culicoides* were attracted to the horse and in flying around a number would come in contact with the castor oil treated papers and become glued to the paper. These papers were brought into the laboratory and the total *Culicoides* were counted, using a grid beneath the paper. Six papers were used in each trap and at times four horse traps were operated four nights each week. These were operated Monday through Thursday night exclusive of holidays. Occasionally one of the boards would fall down and that count would be lost but the collection would be dropped so that the average would not be affected.

Although there was considerable variation from trap to trap, the monthly average gave a very definite trend. The graph, Fig. 1, presents the monthly averages of the catches from August 1950 through December, 1953.

The monthly average of *Culicoides* per trap varied from 2 in April and May, 1953 to 684 during December 1950. In a total of 10,829 collections, 1,212,877 specimens were captured, for an overall average of 112 for the period under study.

The adult count began to go up in August 1953 despite the continuation of control measures which had been successful in previous years. The writers have not been able to explain this sudden uptrend since no comparable increase in larval breeding could be found. Larval surveys revealed an increase in the number of positive samples in November, 1953, but most samples had only a very few larvae. It was thought that perhaps the adults had blown in from other areas but this did not seem plausible after larval

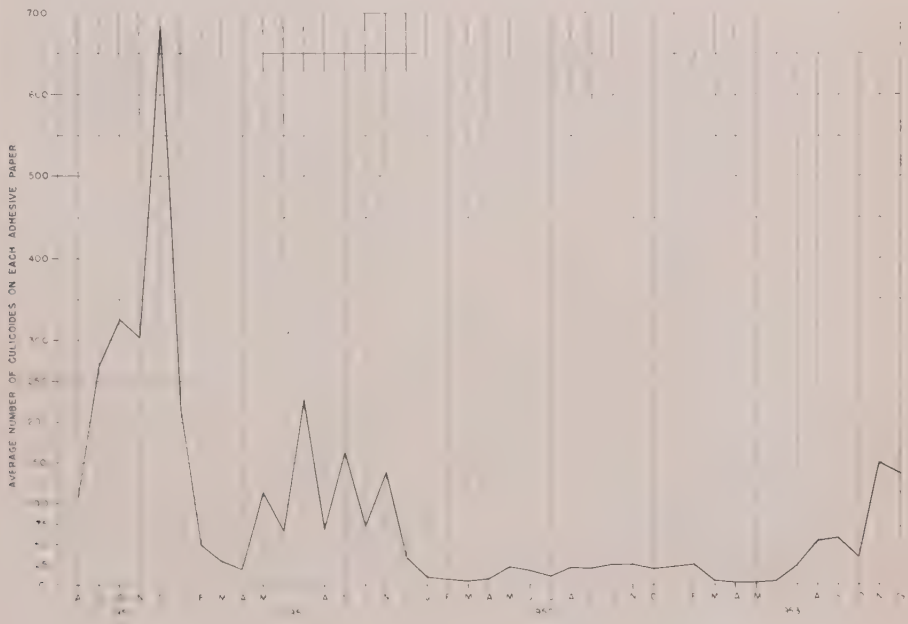

Figure 1.

surveys in other nearby areas showed only a few larvae per sample. Then, too, observations on adult landing rates in the Farfan swamp area exceeded that of other areas. The writers think that the adults were coming from the ditch banks and along the Farfan river system.

Control. Several control measures were undertaken for the specific purpose of reducing the number of adult *Culicoides* in the residential section of Fort Kobbe to a tolerable level. Other control measures were undertaken for other reasons, but may have had some effect on the activities of the adults.

Fog and mist sprays were used at Fort Kobbe at approximately the same frequency as other Army posts in the Canal Zone. These spray operations were designed to kill adult *Anopheles* mosquitoes, but the residents of Fort Kobbe firmly believe that fogging alleviates the *Culicoides* biting nuisance. The writers' observations are that neither operation has a substantial effect on either the number or the activities of the adult *Culicoides* at this location.

Reference has already been made to the installation of tidegates at the mouth of the Farfan River and the resultant elimination of salt water and lowering of the water level in the swamps. These gates were installed in August 1950, but, as expected, they did not have an immediate effect. September, October and November are the months of peak rainfall in the Canal Zone and it was not until February 1951 that the water level in the swamp was substantially lowered. After that time drying was rapid and the swamp was soon covered with vegetation. Concurrent with these ecological changes there was a substantial decrease in the numbers of larvae and adults. It will be noted that there was a definite downward population trend prior to the time that any large scale application of insecticide was made.

Small scale tests made in April 1951 indicated that lindane and dieldrin at the rate of one pound per acre and chlordane at two pounds per acre were each effective in killing the larvae of *Culicoides*. A larger test was conducted in October 1951 when approximately 1,000 acres were sprayed with an L-5 airplane. Half of this area was sprayed with two pounds of chlordane per acre and the other half with one pound of lindane per acre. The other 1,200 acres were sprayed with dieldrin using hand methods of application. In this area mosquito control workers walked along the drainage ditches and sprayed ditch banks and other likely breeding places with dieldrin at the rate of one pound per acre.

From a practical viewpoint all of these spray applications were successful. On 19 and 23 October, one and five days after spraying, a total of 101 mud samples were collected from stations which had been positive for larvae at some time during the previous year. These samples, taken at random from all the treated areas, were all negative on these post-treatment counts.

Adult counts were sharply reduced for a period of about two weeks after the airplane spray application and then increased slowly in November. However, the average for the month of November was less than the average for the same month in 1950. In December 1951, the adult count decreased sharply, averaging only 34, as compared with an average of 684 for December 1950.

During 1952 the monthly averages for adults varied from 4 in March to 25 in October and November. Even the highest counts represented satisfactory control as these numbers were too low to be noticed by anyone on the post. In fact, during 1952 many people lived at Fort Kobbe for months without being aware that such a thing as sandflies existed!

In 1953 there was a gradual increase in the number of adult *Culicoides* collected in the horse traps. There was no corresponding increase in the number of larvae collected from the stations in Farfan Swamps. This contradictory situation caused the authors to spend considerable time searching for the larvae in other less likely breeding places on other sides of the post, but up until this time (April,

1954) no concentration of larvae has been found which was in proportion to the number of adults collected in November and December, 1953.

As a result of severe corrosion and the action of the waves, the tidegates did not function efficiently toward the latter part of 1953. Enough salt water ran back into the river at high tide to raise the minimum water level in the river and many of the drainage ditches to a higher level than had existed in 1952. Also, the mixed ocean and fresh water was more saline. It appears to the authors that a new ecological balance was established in the swamp to which the local population of *Culicoides furens* adjusted itself. In this new situation large numbers of *C. furens* were produced in the drainage system itself such as along ditch banks and other places that were flooded occasionally but not constantly.

In September 1953, Farfan Swamp was sprayed by airplane with dieldrin but due to malfunctioning of the pumps on the spray rig, the dosage was slightly less than one-half pound per acre. A second application at the same dosage rate was made one week later, but the combined effect did not reduce the numbers of adult *Culicoides* reaching the post.

The painting of window screens with 5 percent DDT in kerosene has been found to reduce the number of adults which enter houses through the screens and later bite. However, under the conditions existing at Fort Kobbe, this technique has not been as successful as it was in the tests reported by Trapido (1947).

Discussion and Summary. The writers feel that the *Culicoides* problem at Fort Kobbe has greatly improved since the installation of tidegates. The plant growth has increased enormously in most areas. This shaded condition has limited the breeding to the banks of ditches and streams. It is felt that improved tidegates will continue to exclude tide water from entering the swamp and so change the ecology that breeding will eventually be a negligible factor in this area.

When a heavy flight of adults is experienced aircraft spraying may be employed and is very effective. This is expensive and should be resorted to only in an emergency. Screens, painted with DDT, will exclude *Culicoides* for a short time.

During the period of this study, 1,432 samples of mud were examined for *Culicoides* larvae. A total of 288 samples were positive and 89 had over 100 larvae per sample. During the latter half of 1953 the larval population began to build up again indicating that the soil was again changing to more optimum condition. Leaking tidegates probably caused this. A total of 10,829 adhesive boards were examined during this study and 1,212,877 *Culicoides* were trapped. The average varied from 2 per board in April and May, 1953 to 684 per board in December 1950. The populations were again building up in the latter part of 1953.

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LABORATORY OBSERVATIONS ON A MOSQUITO, *CULISETA MELANURA* (COQUILLETT)

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Recent isolations of virus from field-caught *Culiseta melanura* (Coquillett) have directed attention to this species as a possible vector of both eastern and western equine encephalitis (Chamberlain *et al.*, 1951, Kissling *et al.*, 1954, Holden, 1954). *C. melanura* is a rarely encountered but widely distributed mosquito which breeds throughout the southern and eastern states in swampy or low areas where small permanent waters occur (Carpenter *et al.*, 1946). As recently pointed out by Wallis (1954), the bionomics of the adult, including its feeding habits, are largely unknown. In view of its potential importance as a vector and the paucity of information regarding its life habits, an attempt was made to establish a colony in the laboratory.

On November 6, 1951, 2nd to 4th stage *C. melanura* larvae, associated with those of *Culex territans* Walker, were collected

in a swamp near Macon, Georgia, from seepage holes left by decay of sweetgum stumps. The weather was cold, with temperatures near freezing at night. The larvae were transported immediately by unheated automobile in jars of the original breeding water to the Communicable Disease Center Virus and Rickettsia Laboratory, Montgomery, Alabama. About one-fourth of the collection, consisting of mixed *C. melanura* and *C. territans,* was placed directly into an insectary maintained at 80° F., and 75 per cent relative humidity. The remainder was held temporarily in an unheated room. Nearly all of the *C. melanura* larvae which were placed directly into the insectary died within 18 hours, although all the *C. territans* larvae in the same pans with them survived. Meanwhile, the weather gradually warmed up. A week later, when the midday temperature was near 80° F., the specimens from the unheated room were introduced into the insectary with no apparent ill effects.

The larvae were reared in white enameled pans containing a 2-inch depth of swamp water to which a little swamp muck had been added. Water lost by evaporation was replaced with tap water. A small piece of compressed alfalfa rabbit pellet was placed in each pan daily as food. The surface of each pan was skimmed daily to keep down surface growth.

Larval development was slow, compared with such species as *Culex quinquefasciatus* Say and *Aedes aegypti* (L.), with 2 to 5 weeks required to reach the pupal stage. It was not known at the time whether this was characteristic of the species or a result of prior conditioning to cold temperature in the field. However, it appears as though the latter is the case, in view of a recent report (Wallis, 1954) of rapid development of larvae not exposed to low temperatures. The duration of the pupal stage was 48 to 72 hours. Most of the adults were of normal size.

The adults were kept in 9″ x 9″ x 12″ mosquito-netting cages. No mating was observed, although the specimens were placed under artificial lights of different intensities and near a window exposed to natural afternoon and evening light. It is probable that the lack of mating was due to their being restricted to a small cage. They fed readily upon soaked raisins placed on top of the cages and were long-lived. Some remained alive for 6 weeks, at which time they were killed in the course of another experiment.

They were not avid blood feeders in the laboratory. After being deprived of soaked raisins for 36 to 48 hours, only 10 per cent of the specimens fed upon a 3-day-old chick immobilized on top of the cage overnight. Thirty per cent of similarly starved specimens engorged upon the shaved abdomen of a rabbit. These results do not necessarily indicate a natural preference for mammalian blood over avian, however, as the attracting surface was many times larger in the case of the rabbit than that of the chick. That they will feed upon birds in nature is shown by the results of a precipitin test on a single engorged *C. melanura* light-trapped in Louisiana in 1953, which revealed that avian blood had been ingested.

In virus transmission experiments unrelated to attempts to colonize *C. melanura,* both males and females fed readily in the light upon an infected chick embryo suspension to which a small amount of sugar had been added. Two weeks later the individual females of this group, starved for 48 hours, were induced to feed in the light upon chicks carefully held in contact with them.

In the act of feeding, deep probing rarely occurred. The mouth parts appeared barely to penetrate the skin surface, as labial buckling was seen in only one or two instances. The feedings on chicks carefully held against the mosquitoes required from 10–40 minutes for completion, with an average of 20 minutes in a series of 20 specimens.

Seventeen specimens which engorged upon a rabbit were provided with a 100 ml beaker of swamp water as a site for oviposition. Of these specimens, 11 produced egg rafts. One raft was laid on

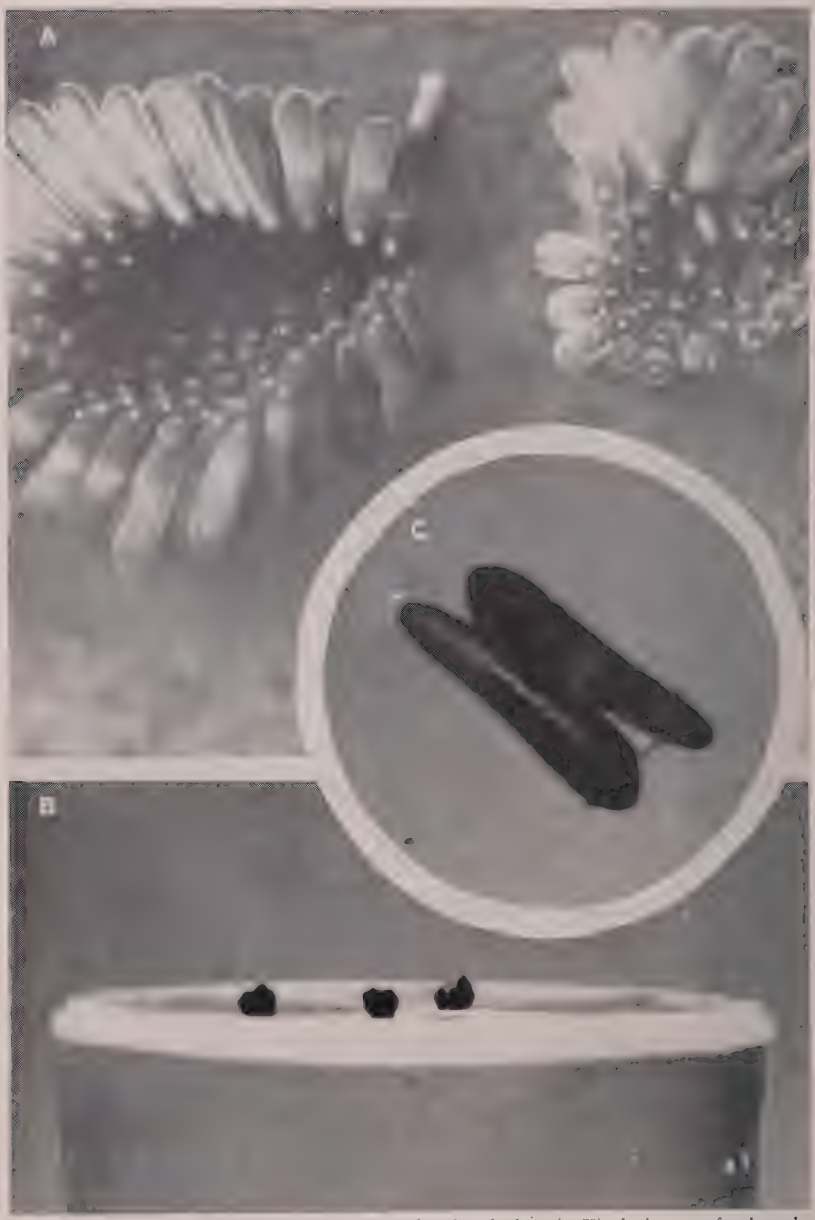

FIGURE 1.—Eggs of *Culiseta melanura*. a, intact rafts, dorsal view (55X); b, intact rafts, lateral view (4.7X); c, individual eggs (90X).

the 4th day, 5 on the 5th day, and 5 on the 6th day after the blood meal. None of the eggs from these rafts hatched, nor from 5 other rafts obtained from a different lot of mosquitoes after chicken feedings.

The egg rafts, examples of which are shown in figure 1-a were about 2.0–2.5 mm. in diameter and bowl-shaped. Some of the rafts were almost perfectly round; others were oval, with one side incomplete. The bottom contours of the rafts were strongly rounded so that only the centrally located eggs were in contact with the water surface, those on the margin and submargin being entirely out of the water (fig. 1-b). Each raft contained about 100 eggs (2 average-sized rafts consisted of 85 and 102 eggs respectively). Individual eggs (fig. 1-c) were about 0.84 mm. long and 0.22 mm. wide at the greatest point. Some had begun to collapse when the photographs were taken, probably because these eggs were infertile.

Successful colonization of this mosquito would be an important contribution to encephalitis workers, for then more critical and complete biological and disease transmission studies could be conducted than are possible when only occasional wild-caught specimens are available. It is hoped that this article will stimulate further investigation of *C. melanura* which may lead to its successful colonization. The authors would appreciate notification by field collectors when large numbers are encountered so that specimens may be obtained for additional laboratory work.

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THE NON-BLOOD FEEDING HABITS OF *AEDES TAENIORHYNDUS* (DIPTERA, CULICIDAE) ON SANIBEL ISLAND, FLORIDA

JAMES S. HAEGER [1]

The feeding of mosquitoes on nectar-producing plants was reviewed by Howard, Dyar and Knab (1912), and more recently by Hocking (1953) whose extensive observations in the Arctic are an exception to the more or less casual observations reported elsewhere in the literature. Such feeding of salt-marsh mosquitoes has not so far been reported beyond the observation of Smith (1904) on *Aedes sollicitans* in New Jersey: "I have seen both sexes of this species feeding in the blossoms of wild cherry and it is quite probable that vegetable juices form a considerable element in the food of this species" (p. 203).

Field Observations. Although *Aedes taeniorhynchus* has been closely studied in Florida since 1948, it was not until the spring of 1953 that feeding on nectar was

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observed. On the evening of April 24 while observing a brood recently emerged on Sanibel Island, it was noticed that many of these mosquitoes were among the tender branch tips of buttonwood (*Conocarpus erectus*), a small tree of salt-marsh and mangrove swamp edges in south Florida. The mosquitoes were crawling and probing on twigs with new leaves, especially about the leaf petioles. They seemed to be feeding on nectar secreted by extrafloral glands on the petioles. The presence of such glands was verified the following day by microscopic examination. On the same night mosquitoes were found feeding on the flowers of black mangrove (*Avicennia nitida*). Both sexes were present and there were as many as 8 or 10 per flower head and several times two were feeding simultaneously on a single flower only 5 mm in diameter. Feeding was further observed on Spanish needle (*Bidens* sp.), not on the flowers present but on green aphid honeydew on the leaves. These observations of April 24 initiated a three-month series of observations, at all times of the day and night on various dates.

Wesenberg-Lund (1921) was the first to mention that mosquitoes in nature often were found with the abdomen swollen by a clear fluid. Nielsen and Greve (1950) used this observation in determining at what time the mosquitoes were feeding. The species these Danish observers studied were rather large and it was easy to observe the clear fluid in the abdomen. In *Aedes taeniorhynchus* this is considerably more difficult, but in both sexes it was possible to see if they had fed on nectar by placing a flashlight at arm's length with the light directed at an angle towards the observer through the abdomens of mosquitoes resting on foliage of shrubs. Those containing nectar or honeydew will, under these circumstances, appear to be clear with the abdomen swollen. Females with ovaries filled with large eggs will also have the abdomen swollen but they will appear opaque or yellowish-green.

FEEDING AND WEATHER. Larsen (1948) found nectar-feeding of mosquitoes to be influenced especially by humidity and wind, but most of her observations were made during adverse cold-weather conditions. In Florida, weather factors usually were of little importance to the flower visits of the salt-marsh mosquitoes, but one observation on the behavior of both sexes feeding on buttonwood flowers during a heavy summer shower should be noted. For a while the feeding adults continued to take nectar heedless of the rain, but when the rain drops became larger and more numerous the mosquitoes proceeded to walk to the cover afforded by leaves and stems. They stayed there motionless until the rain was over and then crawled back to the flowers again to resume feeding and, needless to say, the nectar was quite diluted by this time and they did much probing around before they fed.

MAIN NON-BLOOD FOOD SOURCES. Flower nectar was by far the most important source of sweet food. From April to July on Sanibel Island many flowering plants produce large amounts of nectar. Beekeepers in southern Florida often obtain 150 to 200 pounds of honey per hive per season from flowers growing in or adjacent to salt marshes. The most important plants for mosquito nectar-feeding and their flowering times are as follows:

Plant Species	Months of Flowering J. F. M. A. M. J. J. A. S. O. N. D.
Bidens sp.	
Serenoa repens (saw palmetto)	
Conocarpus erectus	
Coccolobus uvifera (sea grape)	
Avicennia nitida	
Sabal Palmetto (cabbage palm)	

This phenology is for Sanibel Island. Variations in temperature and rainfall for each locality on the Florida coastline result in different phenologies. Thus on Sanibel Island the saw palmetto is still in bloom when the cabbage palm first flowers, whereas at Vero Beach palmetto blooming is over one to three weeks before the palm begins.

Honeydew secreted by aphids is next in importance to flower nectaries as a mosquito food source, although it is much inferior in number of visits.

Leaf petiole nectaries were, as mentioned, found on buttonwood, a salt-marsh transition zone tree. Male swarms of *Aedes taeniorhynchus* are often found over the tops of these shrubby trees. Nectar from the petioles is produced only during the night and early morning. This tree also produces abundant flowers during most of the year except in the wintertime, and thousands of males and females have been observed feeding both night and day on the flowers on numerous occasions. There are two types of perfect flowers borne on separate trees, some with long stamens and others with short stamens. The trees bearing the long-stamened flowers are most often frequented by mosquitoes and have a most distinct honey odor, whereas the flowers of short-stamen type trees are not as strong scented. Only the trees with short-stamened flowers produce seed.

Feeding Time in Relation to Daily Activity. Previous workers have reported that nectar-feeding in mosquitoes is not equally distributed over the twenty-four hours. Larsen (1948), observing species of *Aedes* and *Culex* feeding on the flower heads of *Tanacetum vulgare* in Denmark, found a maximum activity in morning and evening during daylight hours; Nielsen

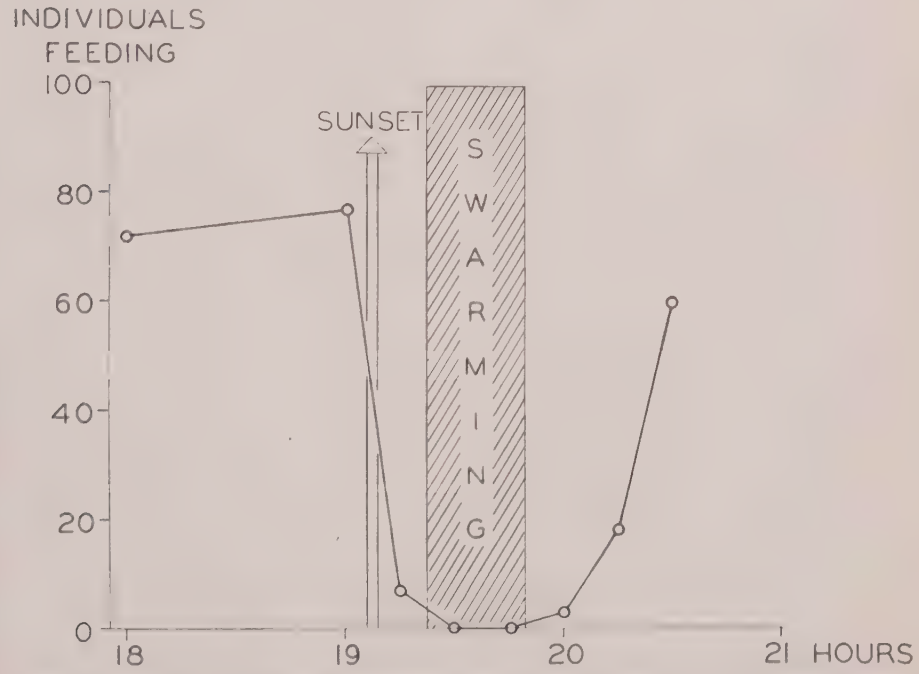

Fig. 1.—Number of *Aedes taeniorhynchus*, both sexes, observed feeding on sweets around sunset. The figures are means for the four days, May 24–27, 1953. Brood 2.

and Greve (1950) found that feeding took place before the evening swarms at dusk and after the morning swarms at dawn. In *Aedes taeniorhynchus* it was also found that there were main feeding periods, both during the daylight and dark hours. In the general population not newly-emerged the daily sequence was as follows. In the middle of the day, between 1100 and 1500, mosquitoes were never found feeding, but between 1600 and 1700 there were many on the food sources. Around sunset there was a very sudden decrease, and during the period of male swarming (from about 15 to 40 minutes after sunset) not a single mosquito of any sex was feeding. Four of the several observations at this time of day are represented in Figure 1. When the swarming period was over, feeding started again and went on for several hours. During the middle of the night, from about 2300 to 0300, few were feeding and these were mostly males, but there was never a complete cessation as at midday. In the morning (Figure 2) there was usually a small increase in the number of feedings before all feeding stopped, again, during the morning swarming of the males. After that there was a very sharp rise in feeding during sunrise, and feeding persisted until 0900 or 1100 (Figure 3).

Most of the observations on feeding were made on two distinct broods, one of them emerging in the last part of April and the other in the last part of May. In both cases it was found that the flower visits were observed in abundance for the first ten days of the brood, after which there was a sharp decline in feeding and many flowering plants had to be searched to find any nectar-feeding mosquitoes. There seemed still to be a very large population of mosquitoes at that time and the decrease in nectar feeding appeared not to reflect a decrease in population.

The large emergence of May 21–22 took place in a black mangrove swamp con-

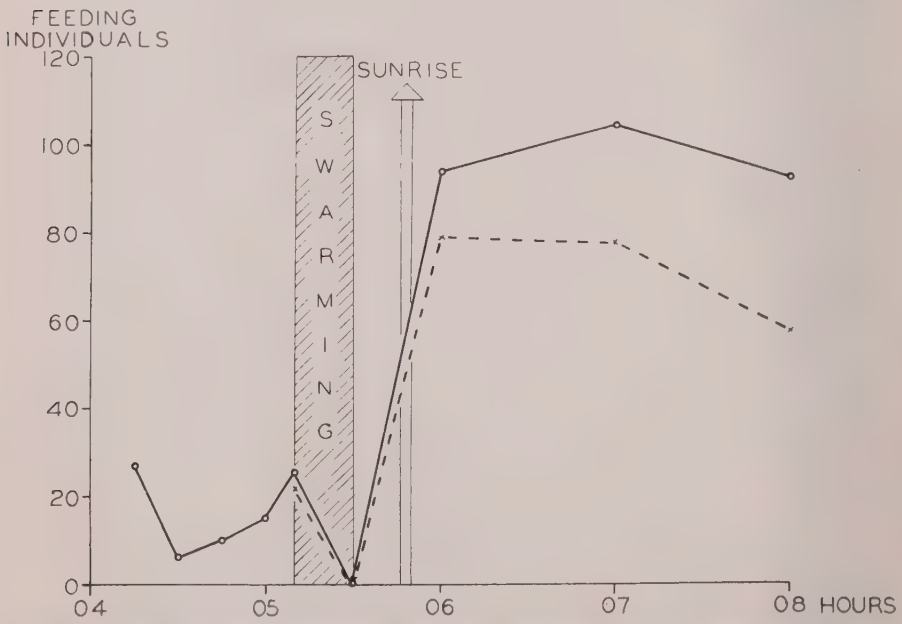

FIG. 2.—Number of *Aedes taeniorhynchus*, both sexes, observed feeding on sweets around sunrise. The solid line is for April 30, 1953 and the broken line for the mornings of May 3 and May 5, 1953. Brood 1.

taining a large area of dead trees beneath which were patches of the saltwort (*Batis maritima*). Adults had been emerging since early morning and when observations were being made at 1500 thousands of adults, both male and female, were ravenously feeding on the flowers of small black mangrove trees. This feeding continued toward evening and sunset. By 1900 they were not only feeding at low levels but also on trees 18 to 24 feet above the marsh. All flower heads at this height were covered and hundreds of mosquitoes hovered over the clusters. They continued to feed right up to the time of exodus, between 1920 and 2045, and many matings took place as they left the flower heads. There was in this case, of course, no question of male swarming period since this swarming occurs only after the migration (Nielsen and Nielsen 1953).

Observations on Other Species. During the course of this study four other species of mosquito were seen feeding at night between 2000 and 2400 and one species at about 1600 in the afternoon. One male of *Aedes sollicitans* was found feeding on honeydew of green aphids covering the leaves of *Bidens* at 2030 on April 25. Again on April 30, 2 male *sollicitans* were seen on honeydew of aphids and 3 females on *Bidens* flowers. On July 2, 2 male *Psorophora howardii* were found feeding on the flowers of buttonwood at 2040. This is the first nectar-feeding record for this species. On the night of April 30, 3 males and 2 females of *Anopheles atropos,* 5 males and 1 female of

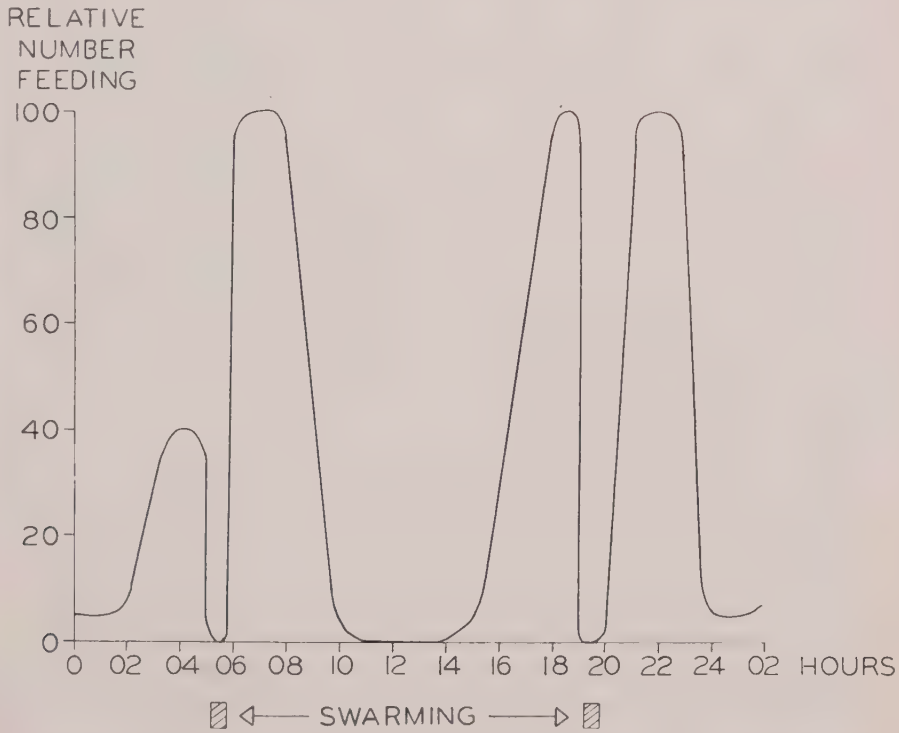

Fig. 3.—The daily cycle of sweet feeding activity in *Aedes taeniorhynchus*. The relative number is an approximation based on all observations and has no numerical value.

Culex nigripalpus were observed feeding on honeydew on the same plants with *Aedes sollicitans*. On May 27, 4 males and 1 female *Culex nigripalpus* and 2 male *Anopheles atropos* were again found feeding, same location as above, on aphid honeydew on leaves of *Bidens*. Finally, a fifth species, 1 female of *Psorophora ferox*, was observed feeding on the flowers of buttonwood at about 1600 on August 4.

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AN EASILY CONSTRUCTED RACK FOR MASS STAINING ONE HUNDRED MALARIA SLIDES

GEORGE J. BURTON [1] AND CHARLES E. KOHLER [2]
United States Public Health Service

A rack for mass staining at least 100 malaria slides or any other kind of slides can be easily made from an ordinary cardboard-covered, wooden-framed slide box made to hold 100 slides in two columns of 50 slides each. There are several sizes of such slide boxes. The smallest one, measuring about 7½ inches wide and 8¾ inches long, was selected for this rack, although the larger sizes may also be used.

First, the two hinges at the back are removed, and the upper and lower halves are separated. Then the cardboard is cut away from the wooden frame of the cover half. Any paper remaining attached to the wooden frame may be removed by soaking the frame in water until the paper can be peeled off. One of the long sides of the rectangular frame is then removed, preferably by sawing, since the dove-tailed joints are rather secure. Two small nails or brads are then nailed at each of the remaining two corners for reinforcement. This will become the handle of the rack.

In preparing the other part of the rack, the three grooved units of the lower half of the original box are removed individually after first tearing away the thin cardboard backing behind each unit. Then the cardboard is cut away from the frame, and all vestiges of paper are removed by soaking the frame in water. Small nails are used to reinforce the four corners, two at each corner.

All that remains of the original slide box now are one complete wooden frame, a 3-sided frame, and the 3 grooved units for holding slides. The latter are then nailed directly to the 4-sided frame in the exact positions they originally occupied in the slide box.

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[2] Malariologist, Senior Sanitarian (R), USPHS, FOA Mission to Liberia.

If the slides are inserted into the box, they will fall through, so it is necessary to support them. The writers used 35-pound stainless steel fishing leader wire, although any other kind of fine wire will do. Two sections of this wire are secured tautly by nails at the bottom of each half of the rack, resulting in 4 longitudinal slide supports. The 3-sided or U-shaped frame is now nailed to the lower section, forming a handle for the rack (Figure 1).

Fig. 1.—Completed staining rack.

In order to prevent warping of the wood or change in pH of the staining solution, the entire rack is given two coats of transparent spar varnish. The rack can be used indefinitely without affecting or being affected by the staining solution.

The stain used by the writers is Giemsa stain for staining thick and thin smears simultaneously in a dilution of one part of stain to 50 parts of buffered distilled water. This is permitted to act for 45 to 60 minutes, and is followed by a wash for 3 to 5 minutes. The staining solution and wash water are buffered to between 7.0 and 7.2. The same staining solution may be used consecutively for several stainings, but should not be kept until the next day.

The staining solution is prepared in a stainless steel or white-enameled rectangular staining dish of adequate size so that when the rack is placed into the dish the surface of the liquid will completely cover the slides, preferably with ⅛ to ¼ inch to spare. Twenty additional slides may then be laid horizontally upon the other slides, thus making it possible to stain as many as 120 slides at once. When washing the slides a separate dish is used, similar to that used for staining, but if the stain is to be used only once the solution may be poured off and the wash water poured into the same dish.

Since with the rack described above it is possible to stain between 100 and 120 slides at the same time with a minimum of handling, it is of considerable advantage in conducting a blood parasitemia survey for malaria parasites. If staining is conducted continuously, 1,000 malaria slides can be stained in one day with a single rack.

A LIGHT TRAP AND MECHANICAL ASPIRATOR OPERATING ON DRY CELL BATTERIES

D. B. NELSON AND R. W. CHAMBERLAIN *

Entomologists have long recognized the need for a small, portable light trap for use in primitive areas which are without electric power lines, where the conventional 110-volt New Jersey trap cannot be operated. The use of generators as a power source for the New Jersey trap greatly limits portability and may be prohibitive in cost. Present modifications of this trap to operate from 6-volt automobile batteries are also of limited value because of the considerable weight of both the trap and batteries (about 15 and 60 pounds respectively), the high cost of the batteries, and the need for daily recharging.

To make live collections of mosquitoes in the swamps of Louisiana, a miniature New Jersey-type trap weighing only 1½ pounds and needing only 4 pounds of batteries was developed. It utilizes a small motor [1] operating on dry cell current. This same motor was also incorporated into a small mechanical aspirator for collecting mosquitoes found in diurnal resting places and biting on man.

The motor is of the alnico-magnet reversible type such as that used by the toy industry, and draws very little current. It has silver-graphite tips on the brushes for long life and will operate on 1½ to 6 volts. Some of these motors used in light traps have now run over 500 hours and show very little wear, although they have had no maintenance other than a tiny drop of electric motor oil on the bearings every 75 to 100 hours. These motors are operated on a 3-volt current from dry cell batteries, which also furnish current for the light. Although the motors are extremely durable for their size, failures occasionally occur; therefore, spare motors should be kept on hand for replacement.

The batteries found most satisfactory are the cylindrical 1½-volt doorbell or ignition type. Two of these batteries connected in series furnish sufficient current to operate the motor and burn a 3.8-volt bulb (as in 3-cell flashlights) constantly for at least 20 to 30 hours. The light provided is sufficient for attracting considerable numbers of mosquitoes in confined areas, such as swamps and deep woods. If, after one period of operation, the batteries are rested for 3 or 4 days, enough rebound usually occurs for a second night's operation before discarding. Traps to be used in a permanent collecting site, where portability is not important, may be operated from an automobile battery provided a 6-volt bulb is substituted for the 3.8-volt bulb.

The details of construction of the light trap are shown in figure 1. Plexiglas [2] plastic is used wherever possible because of its strength and light weight. Parts are connected with bolts whenever practicable so that the trap can be disassembled easily. Most of the bolts are secured by tapping threads into the plastic to reduce the use of nuts. For permanent fittings, a cement made of fragments of Plexiglas dissolved in chloroform is used.

The main body of the trap (1) consists of a section of ⅛-inch-thick Plexiglas tubing 10 inches long and 3½ inches outside diameter. A cone-shaped hood (2) 7

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[1] Wilson's Tiny Atom electric motor with silver-graphite tipped brushes, Wilson's of Cleveland, 425 Lakeside Ave., N.W., Cleveland 13, Ohio.

NOTE: Trade names are used as a means of identifying the product and their use does not constitute endorsement by the Public Health Service.

[2] Rohm and Haas, 712 Locust St., Philadelphia, Pa., manufacturers. Obtainable in small quantities from AAA Brands, 510 Ponce de Leon Ave., N.E., Atlanta, Ga.

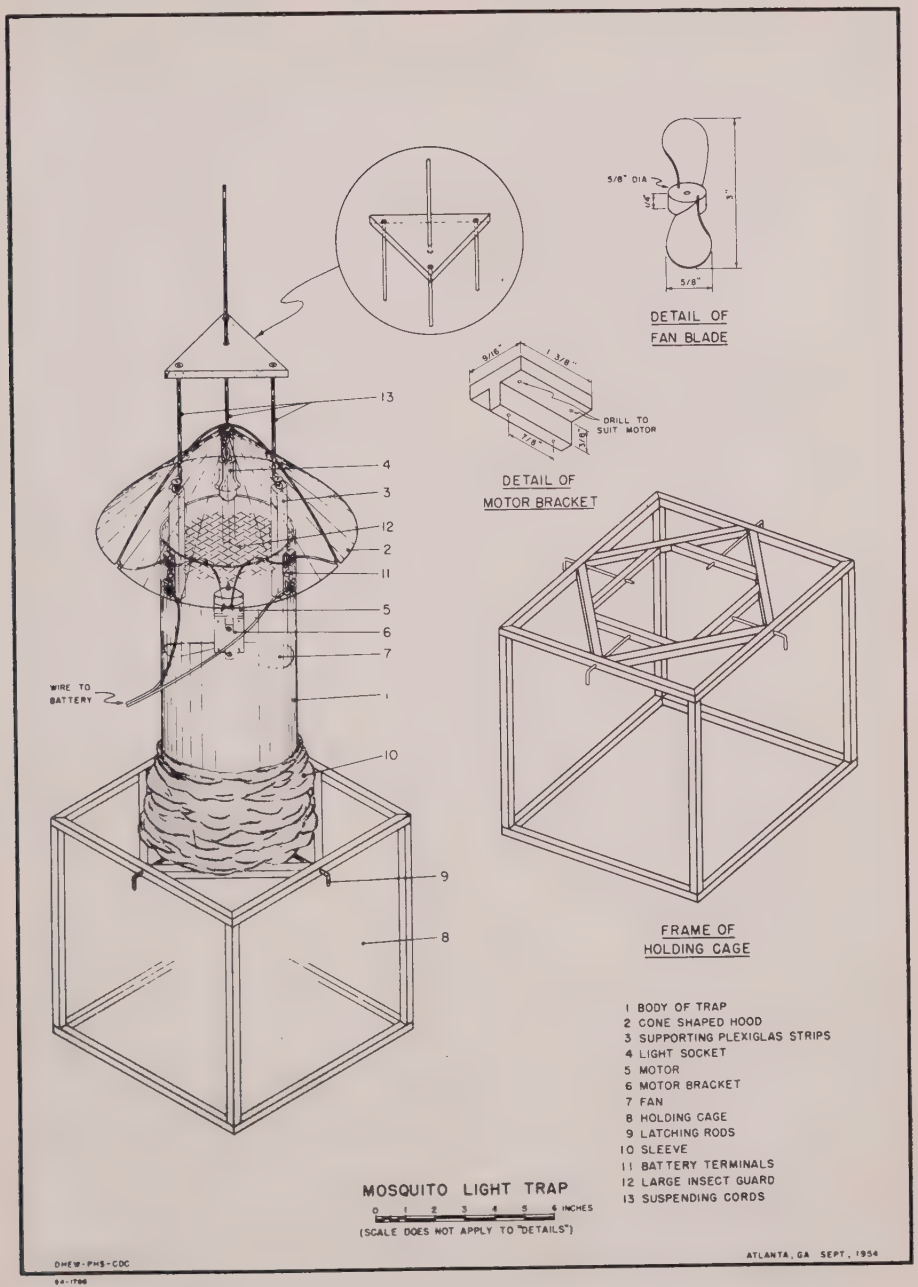
5/8" DIA
5/8"
DETAIL OF FAN BLADE
9/16"
1 3/8"
DRILL TO SUIT MOTOR
7/8"
DETAIL OF MOTOR BRACKET
FRAME OF HOLDING CAGE
WIRE TO BATTERY
1 BODY OF TRAP
2 CONE SHAPED HOOD
3 SUPPORTING PLEXIGLAS STRIPS
4 LIGHT SOCKET
5 MOTOR
6 MOTOR BRACKET
7 FAN
8 HOLDING CAGE
9 LATCHING RODS
10 SLEEVE
11 BATTERY TERMINALS
12 LARGE INSECT GUARD
13 SUSPENDING CORDS
MOSQUITO LIGHT TRAP
0 1 2 3 4 5 6 INCHES
(SCALE DOES NOT APPLY TO "DETAILS")
DHEW-PHS-CDC
ATLANTA, GA SEPT., 1954

FIGURE 1.

inches in diameter and 3¼ inches high, made of Cordiflex [3] or thin cellulose acetate sheeting, is supported above the trap body by 3 fitted, Plexiglas strips with dimensions of ½ x ¼ x 4 inches (3). Hanging by its own wires from the center of this cone is a light bulb socket taken from a string of series-type Christmas tree lights (4). The motor (5) is mounted in a vertical position 2 inches from the top of the body tube by a bracket (6) made of ¼-inch Plexiglas so that the shaft is in the central axis of the tube. To the shaft of the motor is attached a 3-inch fan with blades of Cordiflex (7). The hub of the fan is a small disc of Plexiglas with a small central hole for tight insertion of the motor shaft. A ready-made plastic model airplane propeller has been found to operate with nearly equal efficiency.

At the bottom of the body-tube are 4 holes equally spaced for attaching a 7 x 7 x 7-inch plastic cage. This cage (8), designed for capturing specimens alive, is made of ¼-inch strips of Plexiglas and covered with 32 x 32 mesh Lumite [4] plastic screening. At the top of the cage are 4 small rods (9) which slide through holes in the top braces and into the holes in the bottom edge of the body-tube, latching the cage to the trap. A marquisette sleeve (10) slightly larger in diameter than the body-tube is stitched to the screening of the top of the cage and slides up on the tube when attached.

If it is desired to substitute a cyanide jar for the cage, it will be necessary to modify the trap by the addition of a screen cone. In doing this, care should be exercised not to interfere with the free down-draft from the fan or the efficiency of the trap will be considerably reduced.

Mounted near the top of the body-tube are 2 double-clip brass connectors (11), to which the wires from the light, motor and batteries are connected. Three small pieces of Plexiglas are mounted inside and near the top of the body tube to support a ¼-inch mesh hardware-cloth moth and beetle guard (12). The trap, less batteries, is hung by cords (13) from the braces supporting the cone-shaped hood.

The principle of the aspirator is one of centrifugal air displacement, with incoming air supplied through the aspirator tube to the center of the fan hub. A 6-volt switchman's lantern battery was found to be the best source of current for the aspirator, as high fan speed is necessary for efficient operation. Also the lantern battery is small enough to fasten to the collector's belt or fit into a pocket.

The details of construction of the aspirator are shown in figure 2. Two circular pieces of Plexiglas ¼-inch thick and 3 inches in diameter, held ¾-inch apart by 4 equidistant Plexiglas spacers on the periphery, form the housing for the fan. The fan, consisting of 4 Cordiflex blades set in a Plexiglas hub, rotates between the 2 discs with only enough clearance to prevent rubbing. The motor shaft runs through a small hole in the exact center of one disc. A depression is turned out on the central portion of the outer surface of this disc to receive the convex portion of the motor. The flange on the base of the motor is cut away to allow a close fit against the disc so that it can be cemented into place.

A tapered hole is bored in the center of the other disc, opposite the motor, of sufficient diameter to permit snug accommodation of a No. 5 rubber stopper. The collecting assembly is firmly fitted into this hole.

The collecting assembly is made up of one No. 5 rubber stopper, two No. 6 rubber stoppers, a plastic cylinder 28 mm in diameter and 70 mm in length (a cut off Lusteroid centrifuge tube [5]), one piece of glass tubing 12 mm x 55 mm, and another of the same diameter and approximately 6 inches long. All the stoppers are bored to allow insertion of the glass

[3] A type of plastic sheeting used in rear windows of convertible automobiles. It, or similar material, may be obtained from automobile body shops in most cities.

[4] Chicopee Manufacturing Corporation of Georgia, Lumite Division, 40 Worth Street, New York 13, New York.

[5] Obtainable from any scientific supply house.

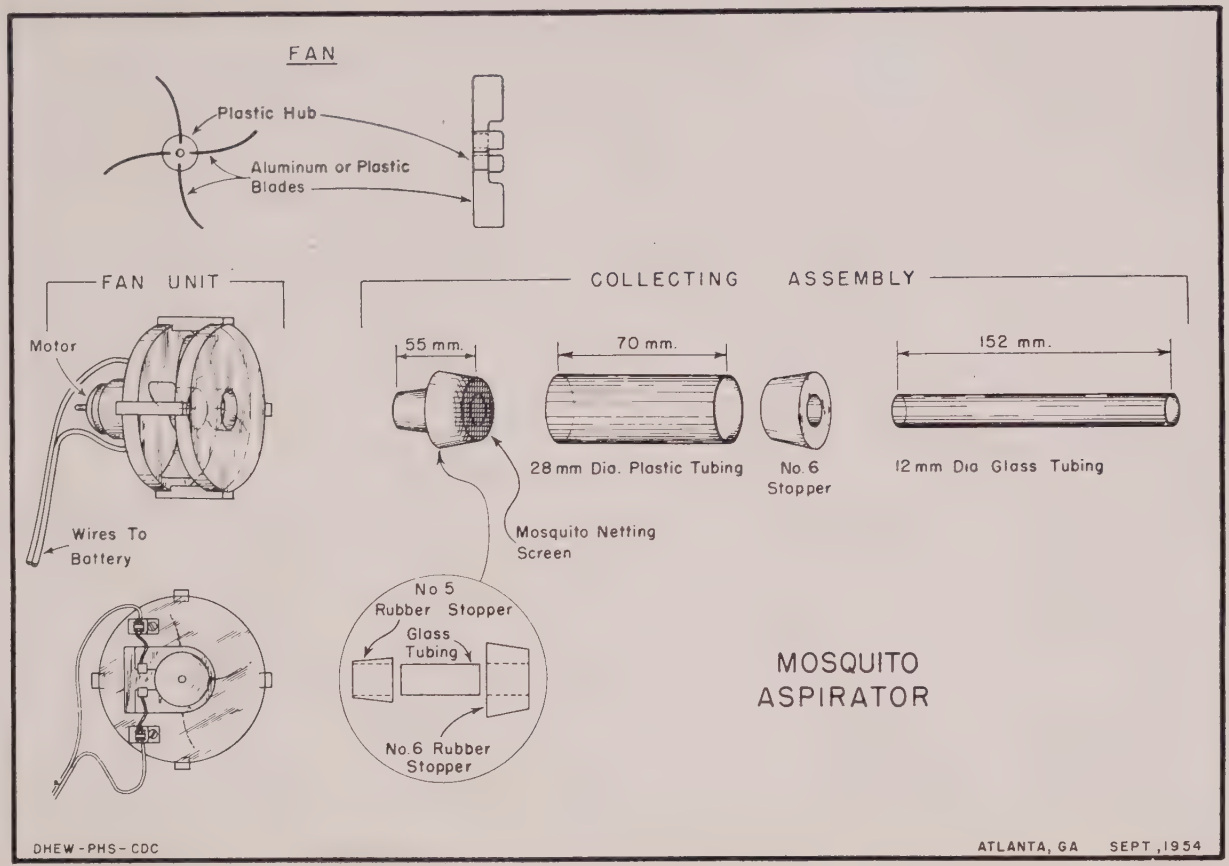
FAN
Plastic Hub
Aluminum or Plastic Blades
FAN UNIT
Motor
Wires To Battery
COLLECTING ASSEMBLY
55 mm.
70 mm.
152 mm.
28 mm Dia. Plastic Tubing
No. 6 Stopper
12 mm Dia Glass Tubing
Mosquito Netting Screen
No 5 Rubber Stopper
Glass Tubing
No. 6 Rubber Stopper
MOSQUITO ASPIRATOR
DHEW - PHS - CDC
ATLANTA, GA SEPT, 1954
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FIGURE 2

tubing. The No. 5 stopper fits into the hole bored in the plastic disc. One No. 6 stopper is attached back-to-back to the No. 5 stopper by the short piece of glass tubing. This No. 6 stopper then fits into the plastic tube. A piece of mosquito netting is stretched across the stopper at this juncture to prevent mosquitoes from passing into the fan. The remaining No. 6 stopper, into which the longer glass tube is inserted, is fitted into the other end of the plastic tube.

Short leads from the terminals of the motor are fastened to brass connectors on the edge of the fan housing for convenient attachment of wires from the battery.

As many as 100 mosquitoes may be collected at one time before it is necessary to discharge them into another container. The collecting assembly can be disconnected quickly from the fan unit and, by blowing gently, the mosquitoes may be discharged into a small cage.

The described aspirator and light trap were used to make collections during the summer with encouraging results. The mechanical aspirator has proved to be superior to the mouth type in that it is less fatiguing to the collector and has greatly increased the number of mosquitoes taken in a given time in biting or resting collections.

The main disadvantage of the trap over the standard New Jersey type is its limited range of mosquito attraction because of its weak light. Most efficient use is made of its light, however, if the trap is placed in wooded areas where lights cannot carry far regardless of intensity and the mosquito populations are more apt to be high. The composition and density of the collections appear to be fairly consistent for a particular area, indicating that the samples obtained may give a reliable index of the light-attracted mosquito population.

For use in primitive areas it is believed that the advantages of the miniature trap outweigh its disadvantages. Its light weight, freedom from dependence upon a power line supply of current, and relatively low cost of operation in view of its portability, make it useful for special operations.

TEMPORARY CONTROL OF ADULT MOSQUITOES AT OUTDOOR PLACES OF PUBLIC ASSEMBLY [1]

W. C. BAKER AND H. F. SCHOOF

During 1953, preliminary studies were conducted at a drive-in theatre in Savannah, Georgia, to determine effective means of achieving temporary nighttime control of several species of pest mosquitoes. Emphasis was placed on the species of mosquitoes present, the relationship of mosquito activity to the efficacy of treatment, and the evaluation of several insecticidal formulations.

The test area was a drive-in theatre (6 acres) located in a lowland surrounded by wooded areas. A nearby field of approximately the same size was used as an untreated check zone.

Treatment of the drive-in theatre area was accomplished by means of a portable jet propulsion fogging unit fitted with a small aperture nozzle. Maximum delivery obtained with this nozzle was 0.135 gallon (512 ml.) of insecticide per minute. At a distance of 20 feet, 51 per cent of the insecticidal particles were in the range of 1 to 19 microns in diameter, 35 per cent

[1] From the Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Savannah, Georgia.

in the range of 20 to 39 microns. All treatments were scheduled to begin 15 minutes after infiltration of the mosquitoes had begun. The general procedure was to apply a barrier strip of fog around the perimeter of the field followed by applications in the roadways between the parked vehicles. Some variations were made to utilize wind directions. As a practical measure, most of the treatments were made by employees of the theatre. Complete coverage of the area required 10 to 15 minutes and approximately 1.1 gallons of insecticide.

Each formulation consisted of the toxicant in a solution of No. 2 fuel oil and kerosene (1:1). The formulations tested were 5 per cent and 2.5 per cent DDT; 2 per cent and 1 per cent chlordane; and 0.25 per cent pyrethrins with 2.0 per cent piperonyl butoxide. In addition, a fuel oil-kerosene solution less toxicant was tested. Two to five replicates were conducted with each formulation.

Evaluation of the tests was based upon mosquito landing rates taken at four stations within the treated zone and at four stations in the untreated area. At each station the total number of mosquitoes that alighted on the inspectors' pants within a 3-minute time interval was noted. This total number of mosquitoes represented six separate counts, the resting mosquitoes being disturbed after each count. Observations included a pretreatment count and posttreatment measurements at 30 and at 75 to 90 minutes after the chemical application. Only those tests in which pretreatment landing rates averaged 50 or more mosquitoes are included in the analysis. Additional information on population estimates and composition was obtained from collections at three light trap stations in the theatre area and one in the untreated zone and from biting records taken at 15-minute intervals between 7:30 and 10:00 p.m. in the untreated zone.

Results. As indicated by trap data and hand collections, *Aedes sollicitans* and *Aedes taeniorhynchus* were the principal pest species present in the area during the time of the study. In the 15-minute hand collections *A. sollicitans* was captured three times as frequently as *A. taeniorhynchus* but this proportion was reversed in the light trap collections. In general these two species constituted 96 per cent of the total mosquitoes taken. However, prior and subsequent to the experimental period of July through September, *A. vexans* was numerous and at times the predominant species in the light trap collections.

Initial observations suggested that the major infiltration of mosquitoes into the theatre area occurred over a definite time interval. Subsequent observations and landing rate counts showed that during the summer period this infiltration occurred at dusk, approximately 20 to 30 minutes after sunset. However, on cloudy nights and in the autumn when the temperatures ranged between 68° and 73° F. in the early evening (6:00 p.m.), the influx took place earlier than at dusk.

The maximum level of mosquito activity in an evening occurred during the 20 to 30 minute period following the initial infiltration. Landing rate counts made in the untreated area at 45 minutes and at 90 minutes after infiltration had begun, showed an average decline of 63 per cent in the level of activity as compared to that present at dusk (Table 1).

Table 1.—Average landing rates on six nights based on six counts each at four stations in an untreated area beginning at the time of mosquito infiltration and at 45- and 90-minute intervals after infiltration, July 13 to August 5, 1953

Starting Time	Initial average	45-minute average	90-minute average
8:00	92.7	17.7	15.7
7:55	53.0	21.0	18.2
7:55	54.5	36.0	37.0
7:55	134.5	77.0	60.5
7:50	119.5	25.2	29.0
7:45	164.5	50.2	60.5
Mean percentage reduction	....	63	64

On cool autumn evenings, high levels

of mosquito activity occurred during the period of infiltration, but 30 and 60 minutes later the counts dropped to less than 8 per cent of the infiltration count, presumably the result of the drop in temperature.

All formulations tested gave satisfactory control of mosquitoes in the drive-in theatre area (Table 2). The pyrethrum produced slightly better control than either the chlordane or DDT formulations. There was no marked difference between the reductions obtained with chlordane or DDT at the two dosages employed for each insecticide.

Treatment of the area 20 minutes prior to the time of infiltration did not give effective abatement.

As a measure of the toxic value of the solvent against the mosquitoes, fuel oil alone or mixed with kerosene was used in several tests. While a considerable reduction in mosquito density was apparent from the use of either formulation, neither provided effective relief from mosquito annoyance.

DISCUSSION. The marked success achieved with the DDT and chlordane formulations is due in part to the absence of resistance to insecticides in the mosquito population of the Savannah, Georgia, area. Until definite losses in susceptibility occur, the present technique offers an effective and economical method of providing temporary relief from mosquito annoyance to human populations congregating for short periods at night.

Under the conditions of these outdoor experiments, the portable fogging unit proved to be an effective means of dispersing the insecticide. The ready portability of the unit allowed usage on rough terrain and provided good maneuverability.

TABLE 2.—The effect of various insecticidal fogs on adult mosquito populations at a drive-in theatre, Savannah, Georgia, 1953

Formulation	No. of tests	Average landing rates		
		Pretreatment	Posttreatment	
			30 min.	75 min.
Pyrethrins, 0.25 per cent and piperonyl butoxide, 2.00 per cent	4	95.9	0.0	0.4
Chlordane, 2.0 per cent	2	213.7	1.6	2.5
Chlordane, 1.0 per cent	4	107.3	0.6	0.7
DDT, 5.0 per cent	4	59.5	1.3	0.3
DDT, 2.5 per cent	5	126.4	2.5	3.0
Fuel oil, No. 2	2	73.5	7.5	4.0
Fuel oil, No. 2½; kerosene, ½	2	106.2	14.0	...

SUMMARY. Single fog applications of 1:1 fuel oil-kerosene solutions containing (a) 2.5 or 5 per cent DDT, (b) 1 or 2 per cent chlordane, or (c) 0.25 per cent pyrethrins plus 2.0 per cent piperonyl butoxide, to a drive-in theatre area near Savannah, Georgia, provided effective relief from annoyance by *Aedes sollicitans* and *Aedes taeniorhynchus* for an entire evening. Infiltration of the mosquitoes into the area occurred at dusk in the summer period. Application of the fog during or after the infiltration of the mosquitoes into the area was a prerequisite for effective abatement. The maximum period of mosquito activity was during the 20 to 30 minute interval following infiltration. A portable jet propulsion fogging unit provided effective dispersal of the insecticide.

PICTORIAL KEYS TO THE MOSQUITOES OF MEDICAL IMPORTANCE

IX. AUSTRALIAN REGION [1, 2]

DAVID R. COOK [3] AND RICHARD H. FOOTE [4]

The present series of pictorial keys is being produced under a transfer of funds from the Department of the Army to the Entomology Research Branch. They are designed primarily to help public-health workers rapidly separate and identify the mosquitoes of primary medical importance in various parts of the world. The keys are so constructed that they separate the important species not only from each other but also from all others known to occur, or suspected of occurring, in the region. We solicit any suggestions or comments pertaining to the keys and other information presented here in order that our knowledge of diseases and the mosquito fauna of the Australian region might be presented in a more useful way to the non-taxonomist.

Anopheles farauti and *Anopheles punctulatus* are the most common and dangerous vectors of malaria in this region. Of these two species, *A. farauti* has the wider distribution; it occurs from the Moluccas eastward through New Guinea, the Admiralty Islands, the Bismarck Archipelago, the Solomon Islands and the New Hebrides, and extends into northern Australia to about 17° to 19° south latitude. Malaria in the South Pacific is generally understood to be bounded by longitude 170° east and latitude 20° south, the junction of these two lines lying just north of Anietzum, the southernmost island of the New Hebrides group. This corresponds to the distribution in the New Hebrides of *A. farauti*. Neither malaria nor species of the genus *Anopheles* occur in New Caledonia or New Zealand. In dry weather *A. farauti* breeds in all kinds of collections of water close to man and during the rainy season it breeds readily in small man-made depressions. *A. punctulatus* occurs over much the same range as *A. farauti,* but it is absent from Australia and the New Hebrides. It also breeds in all sorts of small collections of sunlit ground and rain water, but is more characteristically a species of inland and elevated areas. Females of these two species bite by preference in complete darkness, although they are attracted to houses by lights at night and readily enter. The proximity of their breeding places to man, their ability to mature the malaria parasite, and their liking for human blood conspire to make these two *Anopheles* of primary medical importance over most of their range wherever they occur in large numbers. South of 19° south latitude on the Australian mainland malaria is restricted to short-lived and narrowly localized outbreaks. This sporadic malaria is transmitted by *Anopheles annulipes,* which breeds in situations quite similar to the two former species, enters houses to feed early in the evening, and afterward tends to rest inside during the night. This anopheline occurs in New Guinea and northern Australia as well, but is regarded as a secondary vector in these areas. *Anopheles bancroftii,* although occurring in northern Australia where it is not regarded as being an important vector, transmits ma-

[1] Previous keys and issues of Mosquito News in which they appeared are for Korea (I) and Formosa (II), Vol. 13, No. 1, 1953; Malaya (III), Vol. 13, No. 2; Anglo-Egyptian Sudan (IV), Vol. 13, No. 4; French Indochina (V), Vol. 14, No. 1, 1954; Philippine Islands (VI), Vol. 14, No. 2; Spain and Portugal (VII) and West Indies (VIII), Vol. 14, No. 3.

[2] Keys were drawn by Sally D. Kaicher.

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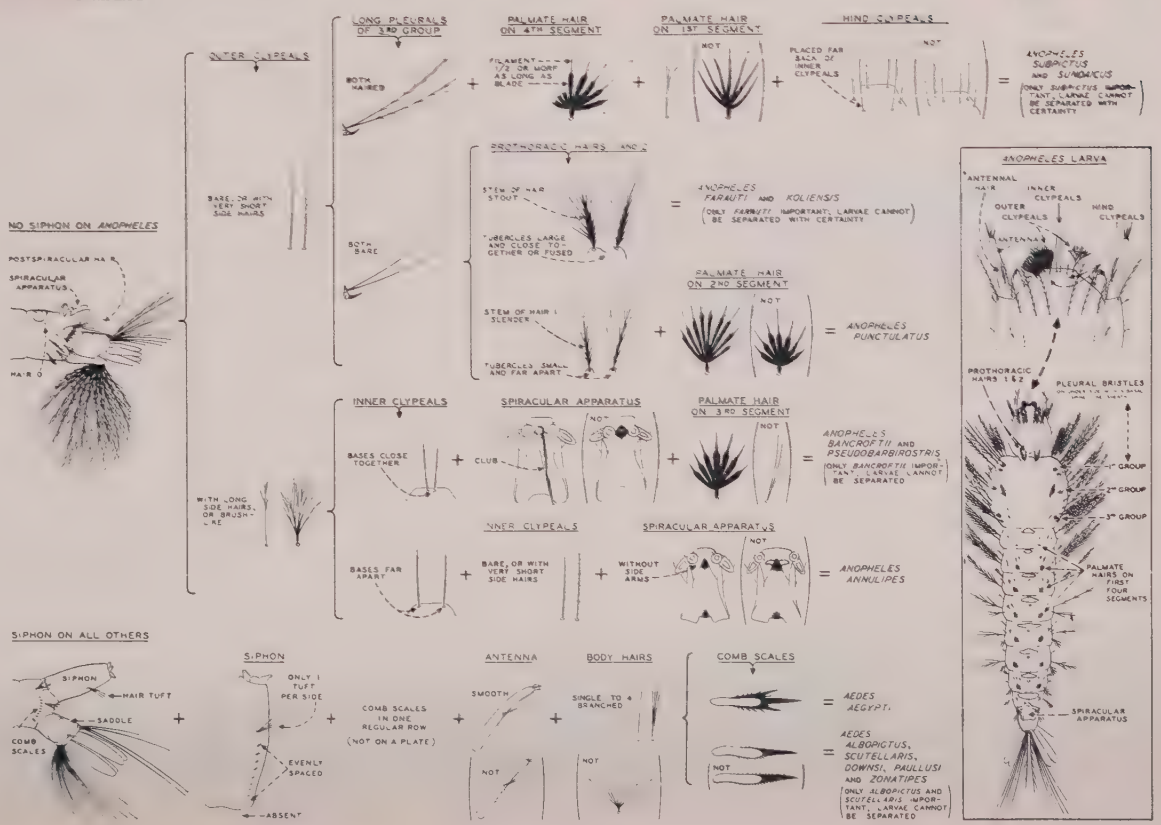
MOSQUITOES OF MEDICAL IMPORTANCE — AUSTRALIAN REGION

[AREA INCLUDED: AUSTRALIA, NEW ZEALAND, POLYNESIA, MICRONESIA, MELANESIA, NEW GUINEA, MOLUCCAS AND TIMOR]

IMPORTANT
A SPECIMEN MUST HAVE ALL CHARACTERS LISTED FOR THAT SPECIES

FULL-GROWN LARVAE



MOSQUITOES OF MEDICAL IMPORTANCE – AUSTRALIAN REGION

[AREA INCLUDED AUSTRALIA, NEW ZEALAND, POLYNESIA, MICRONESIA, MELANESIA, NEW GUINEA, MOLUCCAS AND TIMOR]

IMPORTANT
A SPECIMEN MUST HAVE ALL CHARACTERS LISTED FOR THAT SPECIES

FEMALES
[MALES HAVE BUSHY ANTENNAE AND DO NOT BITE]

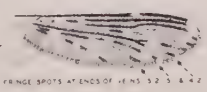
INSECT DEPT. BEPQ USDA UNDER FUNDS ALLOTTED BY SECRETARY OF ARMY MAY 1954

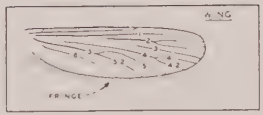
LONG PALPS ON *ANOPHELES*

PATTERN ON PALP
FOUR OR MORE WHITE BANDS (THESE MAY BE OF VARIOUS WIDTHS)
+
HALTERES
LIGHT AT BASE, DARK AT TIP
+
2ND ABDOMINAL SEGMENT
VENTRAL SIDE WITHOUT SCALES
+
PATTERN ON WING
XENO I WITH 12 TO 15 DARK PATCHES
PATTERN ON PROBOSCIS
= *ANOPHELES FARAUTI*
= *ANOPHELES PUNCTULATUS*

XENO I WITH 6 TO 9 DARK PATCHES
+
XENO 4 WITH SOLID OR MORE DARK PATCHES IN FRONT OF FORK
+
PATTERN ON HIND TARSUS
= *ANOPHELES ANNULIPES*

ONE BROAD AND TWO NARROW WHITE BANDS
+
LIGHT BAND AT TIP OF PALP APPROXIMATELY SAME LENGTH AS PRECEDING DARK BAND
+
PATTERN ON HIND FEMUR
ENTIRELY DARK
= *ANOPHELES FARAUTI*

ENTIRELY DARK
+
PATTERN ON HIND FEMUR
SPECKLED
+

FRINGE SPOTS AT ENDS OF VEINS 1, 2, 3, 4 & 7
= *ANOPHELES BANCROFTII*

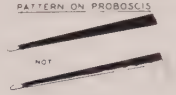


SHORT PALPS ON ALL OTHERS

PATTERN ON TOP OF THORAX

PATTERN ON SIDE OF THORAX
WHITE SCALES FORMING STRIPES
+

WHITE SCALES FORMING IRREGULAR PATCHES
+

PATTERN ON PROBOSCIS


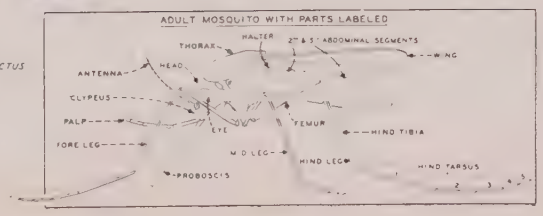
+
WHITE BAND ON TOP OF ABDOMINAL SEGMENT 3 TOUCHING END OF PRECEDING SEGMENT
= *AEDES ALBOPICTUS*

PROBOSCIS ENTIRELY DARK
+

= *AEDES AEGYPTI*

WHITE BAND ON TOP OF ABDOMINAL SEGMENT 5 COMPLETE
+
PATTERN ON HIND TARSUS
DARK BAND ON HIND TARSAL SEGMENT 4 MUCH NARROWER THAN PRECEDING LIGHT BAND
+
= *AEDES SCUTELLARIS*

ADULT MOSQUITO WITH PARTS LABELED



laria in New Guinea, where it occurs in large numbers and is often more heavily infected than *A. farauti*. The species is an inhabitant of low, marshy countryside and its larvae are largely restricted to shade in jungle swamps and similar situations. Females are nocturnal biters of both man and domestic animals and are commonly found resting on walls inside houses and cattle sheds. *Anopheles subpictus* is essentially an Oriental mosquito whose distribution extends eastward into the Moluccas and New Guinea. Larvae have been found only along the coastal regions in open or partly shaded semitidal pools or in grassy fresh water pools nearby. In the Orient females are domestic, but in New Guinea this species has not been observed to bite in large numbers. This species is included in the key because it is an important vector of malaria in other parts of its range.

Other *Anopheles* species and varieties known or assumed to be present in the Australian Region are *amictus* var. *amictus*, var. *hilli, annularis, annulipes, annulipes* var. *mastersi, atripes, bancroftii* var. *barbiventris, bancroftii* var. *pseudobarbirostris, barbirostris, barbumbrosus, clowi, nigerrimus, incognitus, insulaeflorum, karwari, kochi, longirostris, lungae, maculatus, meraukensis, minimus, nataliae, novaguinensis, philippinensis, powelli, solomonis, stigmaticus* var. *corethroides, stigmaticus* var. *stigmaticus, sundaicus, tessellatus* and *vagus*.

Of the approximately 360 non-anopheline mosquitoes occurring in the Australian region and Pacific Islands, only three are felt to be of primary medical importance. *Aedes aegypti* occurs throughout this region northward to Formosa and the Ryukyus, eastward to include Polynesia and Micronesia, and southward through Melanesia and the northern portion of the Australian mainland. In many areas of this region, however, *A. aegypti* is restricted to cities visited by ocean traffic, and breeds in all sorts of artificial containers in urban areas close to man. It is an efficient vector of yellow fever and dengue. The former disease is absent from the Australian and Pacific area, but dengue is widespread, and is transmitted not only by *A. aegypti* but by *Aedes albopictus, Aedes scutellaris,* and probably *Aedes polynesiensis* as well, all of which are somewhat less domestic in their breeding habits than *A. aegypti*. *A. albopictus* does not extend much farther, if at all, west of longitude 150° east; *A. scutellaris* transmits dengue in New Guinea and parts of the New Hebrides; and *A. polynesiensis,* which keys out with *A. scutellaris* in the accompanying plates, in Tahiti, American Samoa, and the Marquesas Islands. An epidemic of Japanese equine encephalitis occurred on Guam in 1947 and 1948, but its vector is not known.

Walter D. Henderson, Librarian of the Association, whose address is Box 27, Barnegat, N. J., again makes a plea for any extra copies of *Mosquito News* that anyone can supply to fill in the files of those numbers that are exhausted or in short supply. Details follow: *Issues that have been exhausted:* Vol. 1, No. 4; Vol. 3, No. 1; Vol. 8, No. 1; Vol. 10, Nos. 1 and 4; Vol. 11, No. 1; and Vol. 13, No. 2. *Issues that are in short supply* (less than 25): Vol. 4, Nos. 3 and 4; Vol. 7, No. 2; Vol. 9, No. 1; Vol. 10, Nos. 2 and 3; Vol. 14, No. 1.

Available back issues of *Mosquito News* are priced at $1.75 per copy, $7.00 per volume.

MOSQUITOES COLLECTED IN HORSE-BAITED TRAPS IN PANAMA DURING 1951 TO 1953 INCLUSIVE AS AN INDEX TO MALARIA CONTROL [1]

FRANKLIN S. BLANTON,[2] CHARLES M. KEENAN, [3] AND E. L. PEYTON [4]

The control of malaria in Panama has been an important mission since the beginning of the construction of the Panama Canal. A great number of papers have been published on malaria and mosquito control in this area.

It is the purpose of this paper to report a summary of the mosquitoes collected in horse-baited traps in and adjacent to Army installations in Panama. The period covered begins with January 1951 and ends October 31, 1953. The present paper deals only with mosquitoes. Such biting Diptera as *Culicoides, Phlebotomus,* Tabanidae, and Simuliidae, often taken from horse traps, are not considered here.

Methods. The adult mosquitoes were collected in horse-baited traps of the Egyptian type as described by Bates (1944). These traps were operated four nights each week throughout the entire period (exclusive of holidays) on all Army posts on both the Atlantic and Pacific sides of the Canal Zone. The purpose of this is to keep an index of mosquito populations which should give an indication of the efficiency of control measures currently in use.

A horse was placed in each trap late in the afternoon and all insects were removed from the trap and brought to the laboratory of the 25th Medical Detachment for identification the following morning. This is a continuation of the exact methods employed and described by Carpenter and Peyton (1952).

History of Animal Baited Traps. The idea for using horse-baited traps is not new. Since the discovery that anopheline mosquitoes are the vectors of malaria *Plasmodia,* many methods of trapping have been devised for the purpose of recording population trends. Not all types of traps work efficiently for all kinds of mosquitoes. Goodwin (1942) found barrels to be quite effective. He painted the inside of these barrels black or red and partially sunk them into the hillside or into a natural bank. The aperture was partially covered in order to make the interior dark and to exclude some of the wind. Smith used nail kegs and placed them in the underbrush where the area was damp. The senior writer has used the Smith technique for the same species, *Anopheles quadrimaculatus,* at Camp Chaffee, Arkansas. This method is successful for several species of *Anopheles* but since very little is known about the resting habits of *Anopheles albimanus* it is not useful for the latter species on the military installations in Panama. Russell and Santiago (1934) described an earth-lined box which they used to attract *Anopheles minimus flavirostris* but this trap, which was useful in the Philippines, was useless in Southern India for *Anopheles culicifacies* and they resorted to mud-thatch or all thatched traps baited with a calf.

Kumm and Zúniga (1944) used an animal baited trap to record seasonal variations of *Anopheles albimanus* and *pseudopunctipennis* in Costa Rica and El Salvador. They used a portable trap which was a modification of the type designed by

[1] Published under the auspices of the Surgeon General, U. S. Army, who does not necessarily assume responsibility for the professional opinions expressed by the authors.

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Magoon (1935). Earle and Howard (1936) reported on the use of a permanent type trap in Puerto Rico. Several variations of the type trap and animal bait have been used throughout the world. Most traps are about 4 feet wide, 8 feet long, and 7 feet high. Our traps have doors at each end. A V-shaped slot permits the mosquitoes to enter the trap but they rarely escape. Marston Bates (1944), who experimented extensively with animal traps in Egypt, reported that when the entrance slot was designed to force the mosquitoes to fly downward there were fewer that escaped.

LOCATION OF TRAPS. The writers have operated horse-baited traps at Albrook Field, Fort Clayton, Fort Kobbe, Fort Davis, Fort Gulick, Fort Sherman, Navy Tank Farm, Fort Sherman Reservation, Camaron, Mount Hope Dump Area, Coco Solito, and the middle Chagres. More than one trap was operated on some posts such as Fort Kobbe and Fort Davis. The Fort Sherman Reservation included traps operated at Gatun Tarpon Club, Chagres S & H Road, mouth of Chagres River, Mojinga Swamp, Devils Beach, and Loma Boracho. These all have been lumped together as Fort Sherman Reservation—a very large area and for the most part unsanitated.

HORSE-BAITED TRAPS VERSUS OTHER METHODS. Carpenter and Peyton (1952) report the results of horse-baited traps and light traps run at Madden Dam, Canal Zone, for one year beginning in October 1948. They caught 50 *Anopheles* sp. in New Jersey light traps compared to 1,587 in the horse-baited traps and for all species of mosquitoes 3,391 were taken from light traps as compared to 65,323 from the horse-baited traps. In contrast to this, Pritchard and Pratt (1944) found a light trap to be superior to horse-baited traps for collecting *Anopheles albimanus* in Puerto Rico. During the period of study reported in this paper no direct comparisons have been made and most of the light trap surveys have been in outlying areas.

Simmons (1939) in his table 57 gives the total anopheline mosquitoes collected by hand in barracks, theaters and other buildings on Army posts in the Canal Zone from 1930–1935. He states that the numbers do not represent the total anophelines present, as catching was done only as a check on mosquito flights. He reports that, in 1933 a total of 8,545 anophelines were caught at 10 Army posts. This work was continued and in 1936, 11,400 *Anopheles* were caught. Simmons estimated that this represented about 10 percent of the *Anopheles* in buildings, which would make 114,000 during 1936. The malaria rate for 1936 was 39.4. The rate increased slightly in 1937 despite the enormous drop in anopheline populations. This shows that the number of *Anopheles* mosquitoes does not always directly affect the malaria rate.

The picture has changed a great deal since Simmons' report. The senior writer did not observe a single *Anopheles* mosquito in his quarters at Fort Clayton in over three years, which shows the high degree of malaria control now in operation in the Canal Zone.

RESULTS: SPECIES COLLECTED. Since malaria vectors were the primary interest, and since it is extremely difficult if not impossible to identify all of the females, especially *Culex* to species, several of the genera were not separated into species. The following identifications, and the numbers of each species or genus captured, constitute the trap records:

Chagasia bathanus 3.

Anopheles: punctimacula 17,960; *albimanus* 6,602; *aquasalis,* 6,413; *oswaldoi* 2,685; *apicimacula* 2,549; *neomaculipalpis* 1,544; *neivai* 238; *pseudopunctipennis* 27; *squamifemur* 11; *triannulatus* 11; *argyritarsis* 10; *anomalophyllis* 9; *eiseni* 6; *strodei* 6; and *Anopheles* spp. 7.

Trichoprosopon: espini 767; *longipes* 22; *digitatum* 16; *lampropus* 4; *magnum* 3; and *rapax* 3.

Sabethes: chloropterus 24; *cyaneus* 1.

Wyeomyia spp. 219; *Limatus* spp. 47; *Uranotaenia* spp. 2.

Mansonia: titillans 49,306; *fasciolata* 18,103; *nigricans* 1,091; *indubitans* 245; *pseudotitillans* 1.

Aedeomyia squamipennis 18.

Psorophora: cingulata 3,474; *ferox* 670; *lutzii* 253; *ciliata* 4; *lineata* 1.

Aedes: taeniorhynchus 11,258; *angustivittatus* 4,710; *fulvus* 478; *serratus* 107; *hastatus* 78; *leucocelaenus* 53; *septemstriatus* 27; *clarkii* 22; *terrens* 2; *leucotaeniatus* 1.

Haemogogus: lucifer 357; *equinus* 196; *spegazzinii-falco* 2.

Culex spp. 28,083; *Deinocerites* spp. 2,195.

Discussion. Fourteen of the seventeen genera of mosquitoes known to occur in Panama are represented in the catches from horse-baited traps over a 3-year period. *Orthopodomyia,* rarely found on our military installations, *Toxorhynchites,* a non-biting mosquito, and *Culiseta,* a northern species, are the only three genera missing from the list.

Some of the pest species such as *Mansonia titillans, M. fasciolata, Aedes taeniorhynchus,* and *Culex* occurred in sufficient numbers to be troublesome at times.

On well sanitated posts the *Anopheles albimanus* count was low. It was lowest at Albrook Field, where 7 specimens were trapped in 333 nights for an average of 0.02 *A. albimanus* per night. At France Air Force Base, a post that was reactivated during the course of these studies, it was high for a sanitated post, with 567 specimens caught in 186 nights for an average of 3 *A. albimanus* per trap night. Fort Sherman was high but this is a very large reservation which was reactivated during the course of these studies. It has been deactivated and all sanitary work has been stopped there. At Fort Davis 381 *A. albimanus* were captured in 907 trap nights for an average of 0.4 per night. During the course of these studies Mindi Dairy was expanded and now surrounds Fort Davis on three sides of the post, and since this dairy is outside the army control it is impossible to keep Ft. Davis free of mosquitoes.

In contrast to the mentioned sanitated areas, the upper Chagres River, a few miles above Gamboa, a total of 4,017 *A. albimanus* were captured in 74 nights operation for an average of 54.3 per trap night.

During this period a total of 161,284 specimens were collected from horse-baited traps of which 6.602 were *Anopheles albimanus,* 17,960 *Anopheles punctimacula,* 13,520 other *Anopheles,* and 123,202 pest species.

Of the pest species, *Aedes taeniorhynchus* is the most serious. This species follows heavy flooding of salt marshes after peak tides and heavy rainfall. There is usually one peak emergence at Fort Kobbe each year followed by one or more minor flights. Several species of the *Mansonia* group, especially *M. titillans* and *fasciolata,* are troublesome at times on some military installations.

Summary. Horse-baited traps have been operated on most of our Army posts during the past three years in order to maintain a constant picture of the mosquito population and to check on the efficacy of control measures. A total of 4,478 trap nights resulted in the capture of 161,284 mosquitoes. Of those, 6,602 were *Anopheles albimanus,* 17,960 *An. punctimacula* and 13,520 were *Anopheles* of other species and 123,202 were pest species.

The population of *Anopheles albimanus* was lowest at Albrook Field, a well sanitated post, with an average of 0.02 specimens per trap night. This, compared to the number collected in the Middle Chagres, an unsanitated area with an average of 54.3 *A. albimanus* per trap night, shows the potential breeding when control methods are not used.

Acknowledgments. To the enlisted technicians of the 25th Medical Detachment and the Malaria Control Branch who have assisted with the identification, grateful acknowledgment is made. Some of the men who should be mentioned are Hector G. Baxter, Wilbur Lowe, Luis G. Pinzon, and Luis Palma. Grateful acknowledgment is also made to Mr. F. C. Henderson and Mr. Harold E. Small, who supervised the collection and care of the specimens from the traps.

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THE SPREAD OF *AEDES SOLLICITANS* (WALKER) IN KENTUCKY

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Aedes sollicitans (Walk.), the salt-marsh mosquito, is now established in Hopkins and Henderson Counties, Kentucky. Complaints of mosquitoes in Madisonville (Hopkins County) led to the collection of five female adults on May 27, 1954. They were found to be *Aedes sollicitans* (Walk.). On June 22, 1954 in the course of a mosquito control program by the City of Henderson and the Henderson County Health Department ten females were collected in Henderson. The following day numerous pupal exuviae and adults were seen at Smith Mills (Henderson County), located about eleven miles west of Henderson; but no larvae were found. Numerous larvae, however, were found at this site on October 5, 1954, breeding in a swamp polluted by salt from oil wells. On June 24, 1954, twenty larvae were collected at Richland, about three miles from Madisonville, breeding in coal-mine polluted water which had overflowed, forming a pool beside a creek. Dr. Alan Stone, of the U. S. Department of Agriculture, has confirmed the identification. Four adult females and six larvae have been deposited in the U. S. National Museum.

A check through the files of mosquito records at the Kentucky State Department of Health showed that on July 4 and 5, 1946, Dr. Frank W. Fisk and Mr. James H. Crawford, then employed by CDC, U. S. Public Health Service, collected 35 females by hand and 9 females by New Jersey light trap at Smith Mills. Their record, however, was unpublished. Blakeslee and Payne (1953) reported one female collected by light trap on June 6, 1953, at Fort Knox (Hardin County).

The finding of this species in the Western Coal Field shows that since 1946 this species has spread at least thirty miles south of Henderson and is breeding in sufficient numbers in mine-polluted water to cause a problem in mosquito control.

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CAGE EQUIPMENT FOR THE STUDY OF MOSQUITOES INFECTED WITH PATHOGENIC AGENTS[1]

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During the course of studies on the transmission of western equine encephalitis virus and of avian malaria parasites by the mosquito *Culex tarsalis* Coq., two types of mosquito cages were designed. These cages were designed with four characteristics in mind: (1) simplicity and durability of construction, (2) ease in handling and feeding adult mosquitoes, (3) sufficient visibility to permit the detection of even slight blood meals in mosquitoes, and (4) minimal opportunity for the escape of infected mosquitoes. The first of these two types of cages served for the emergence of adults and for infection and transmission work with batches of from 25 to 250 mosquitoes. The second type of cage was intended for transmission work with individual mosquitoes.

The first type, illustrated in Figure 1, was a large cage consisting of a cylinder made from 0.020 inch gauge cellulose acetate sheeting, which was fitted and fixed over a wooden disk bottom. The top was a three-quarter inch wooden rim covered with a netting material or plastic screening. A sleeve, consisting of a suitable length of a woman's cotton stocking, was attached to the margins of a four-inch circular hole in the center of the cage. The seam of the cellulose acetate cylinder was readily sealed by running acetone between the lapped edges of the sheet and applying pressure for a few seconds. Similarly, the sleeve was affixed to the cage with acetone as a plasticizer and by applying pressure against the cloth. The top and bottom were held in place by thumb tacks and, in some instances, with adhesive tape in addition. Cages were prepared in a variety of diameters, ranging from 7 to 12 inches, and were usually 20 inches high. In feeding mosquitoes by placing cotton soaked in sugar water on top of the cage, it was found that plastic screening was preferable to cloth netting since the latter became moldy.

Fig. 1.—Cages for Large Mosquito Lots.

For emergence of adults, pupae were placed in small beakers which were then introduced into the cage through the sleeve. Exposure of birds to mosquitoes in these cages was accomplished by clipping the breast feathers, taping the legs together, and placing the bird in a cylindrical holder made from wide mesh wire cloth. Holders were prepared in a variety

[1] Part of a thesis submitted to the Graduate School of the University of Pittsburgh in partial fulfillment of the requirements for the degree of Doctor of Philosophy. This work was actually carried out at the Rocky Mountain Laboratory, National Microbiological Institute, U. S. Public Health Service, Hamilton, Montana.

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of sizes to accommodate various sized birds and are illustrated in Figure 1. Small rodents can be exposed to mosquitoes in these cages in a similar manner, providing the holder does not exceed three and one-half inches in diameter. Exposure of larger rodents to mosquitoes requires a larger aperture and sleeve diameter.

A second type of container was designed for work with single mosquitoes and is illustrated in Figure 2. This container

FIG. 2.—Containers for Individual Mosquitoes.

was prepared from a small rectangle of 0.020 inch gauge cellulose acetate through which a three-quarter inch hole had been punched. This sheet was fitted tightly and sealed with acetone over an uncovered half-pint, cylindrical cardboard ice-cream container, forming a cylinder four inches high. The top of the cylinder was reinforced internally with a one-half inch cardboard ring cut from a similar carton. A small paper cup, approximately one and one-half inches in height, was placed in the ice-cream carton to hold water. The top was then covered with cloth or fiber glass netting which was fixed to the cylinder with acetone. The three-quarter inch hole was covered with a strip of adhesive tape. Mosquitoes were introduced or removed through the hole by use of an aspirator. When cotton soaked with sugar-water was to be placed on top of this container, fiber glass netting was found to be preferable to cotton netting.

Exposure of birds to mosquitoes in these containers was accomplished by clipping the bird on one side, taping the legs together, and taping the bird to the top of the container as shown in Figure 2.

While the first cages of cellulose acetate sheeting were being prepared, it was noted that one lot of 0.030 inch gauge sheeting was toxic to adult mosquitoes. Subsequently, a lot of this heavy gauge sheeting from a second manufacturer was also found to be toxic to mosquitoes. About this time, a paper by Simeone (1953) appeared, indicating that lots of cellulose acetate sheeting which had been treated with diethyl phthalate as a plasticizer in the manufacturing process were toxic to the cigarette beetle, *Lasioderma serricorne*. It was then determined, that the two toxic lots of sheeting had strong and distinctive odors of one of the phthalates. This problem did not manifest itself with sheeting of 0.020 inch thickness or less.

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The Treasurer has sent out bills for dues and subscriptions for 1955 and would appreciate it if the membership would make their returns as promptly as possible so that he will not have to send out second notices. When forwarding returns please mention account number.

A SIMPLE MOUNTING MEDIUM FOR MOSQUITO LARVAE

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Several methods of preparation of mounting media for mosquito larvae have been described by many authors. Most media have both advantages and disadvantages and the one presented here is not expected to differ in this respect. At present it is chiefly interesting as being of indigenous material which is easily supplied and relatively inexpensive, especially in the northern and northeastern parts of Thailand. The methods of preparation are also very simple. Technicians or field assistants can make it in the laboratory or in the field using only ordinary equipment. The medium is clear and colorless, and crystallization has not been observed to occur in slides mounted for several months.

In the north and northeastern part of Thailand, there are *Dipterocarpus* trees growing freely everywhere in the forests, as well as in the villages. *Dipterocarpus obtusifolius* and *Dipterocarpus tuberculatus* are very common species of this genus. Where the bark is broken, the trees produce a resin which, newly excreted, is clear and colorless. Lumps of the resin become cloudy and very faintly yellow with age in nature. This does not seem to be an obstacle in making permanent mounts of dissolved new resin. It is necessary only to pick out the small newly excreted lumps of resin which are clear and colorless, and dissolve them in xylene or eucalyptus oil to obtain the desired viscosity.

The proportion of the resin and two satisfactory solvents are as follows:

1. *Dipterocarpus* resin	10 gm.	2:1
Xylene	5 c.c.	
2. *Dipterocarpus* resin	10 gm.	1:1
Eucalyptus oil	10 c.c.	

Dissolve the resin in xylene or eucalyptus oil at room temperature in a small stoppered bottle. Frequent shaking is needed. Within 2–3 hours the resin is completely dissolved and ready for use.

In the field, it is advised that small quantities be made, so as to shorten the period of dissolving. From the practical point of view, the field workers need take with them only xylene or eucalyptus oil to the field. Newly excreted *Dipterocarpus* resin can be picked up and dissolved in the areas where larval specimens are to be mounted and studied. In the laboratory, a large amount of solution can be made in order to keep it for long use. If the solution is too viscous, more xylene or eucalyptus oil may be added.

The xylene-soluble medium begins to harden within 20 minutes, while the eucalyptus-oil-soluble medium takes 3 days for hardening. No ringing of the cover glass is necessary.

Standard techniques familiar to histologists constitute the preliminary steps of killing, dehydrating and clearing.

Acknowledgments. I wish to express my thanks to Dr. Udaya Sandhinand, Chief Malariologist of Northern Thailand, to whom I am indebted for advice and to Senior Laboratory Assistants for their technical assistance.

EDITORIAL SECTION

PORTLAND TO PORTLAND

Or we might have written Salem to Salem—the intent being to announce that almost simultaneously two new mosquito control organizations, one in the far Northeast and one in the far Northwest, have come into being.

On December 15, 1954 a group of interested persons met in Portland, Oregon to discuss the mosquito problems of Oregon and to plan for the formation of a Mosquito Control Association in that State. A committee was appointed ". . . to plan for the next meeting at which time a definite set of recommendations will be presented to indicate the title, purpose, and objectives of said association." Mr. Milton H. Buehler was selected to be chairman of the committee, and also to act as a representative from this group at the meeting of the American Mosquito Control Association which was held at Los Angeles on January 24–27, 1955. At that time he presented a report on the Oregon organization and described mosquito control activities in that State.

On February 2 and 3, 1955 a group of persons interested in forming a New England Mosquito Control Association met at the University of Massachusetts in Amherst. This group went even farther than the Oregon group for, in the words of Bob Armstrong, they (1) "promptly revised the territory to include New York State and adopted the name *Northeastern* Mosquito Control Association"; and (2) "they hammered out a Constitution and Bylaws and elected a slate of officers."

The AMCA, through *Mosquito News,* extends its best wishes to the two new Associations, and expresses the hope and expectation not only that through them mosquito control will be improved and extended in the territories which they cover, but also that the AMCA will be strengthened correspondingly and that through them its influence will become more widely felt.

It seems not inappropriate at this point to mention Texas. The fact that Beaumont, Texas is almost exactly the same distance from Portland, Oregon and Portland, Maine, may be incidental, but it is significant; for Beaumont, which is to be the scene of the 1956 annual meeting of the AMCA, in being equidistant from the farthest reaches of organized mosquito control in this country, should certainly appeal to all members as being strategically located for a national meeting. Texas is now in the throes of "organizing" and Beaumont, in the Jefferson County Mosquito Control District, is the hub of that activity. With an area of 900 square miles and an appropriation of $125,000 in 1954 for mosquito control, the interest of this District is manifest. With such a district as a nucleus, the AMCA looks forward to the formation of an association in that State similar to those just formed in the Northeast and Northwest. Then, with the Illinois association in the Central States, and the older associations in New Jersey, California, Florida, Virginia and Utah, nearly every section of the country will have some local organization with which its Mosquito Control Districts can affiliate.

What may be even more important, in many states which do not have integrated or centrally organized mosquito control programs or districts, small groups and otherwise isolated or neglected mosquito control programs will have a chance to become better informed, hence more effective; eventually to become parts of the nearest local Association, and through that influence, become members of and receive the benefits of the National Association.

To further these ends, the Regional Directors of the American Mosquito Control Association can be extremely helpful by keeping in touch with the local programs and encouraging contacts with the national Association.

ASSOCIATION NEWS

HAROLD FARNSWORTH GRAY HONORED AT JOINT AMCA-CMCA CONFERENCE IN LOS ANGELES

Harold Farnsworth Gray became willing victim to a two Association conspiracy and difficult as it was, he exhibited at least partial suprise to the variety of honors which were presented to him at the recent AMCA-CMCA joint conference in Los Angeles, California. As the printed program revealed, an appropriate picture of Harold appeared on the cover and the following statement appeared on the inside cover:

"This joint conference of the American and California Mosquito Control Associations is dedicated as a tribute to Harold Farnsworth Gray in appreciative recognition of his dynamic influence upon and his outstanding contributions to the field of mosquito abatement.

"In March 1955 he will retire from active service with the Alameda County Mosquito Abatement District, Oakland, California. This program he initiated

in 1930 and since has successfully managed into deserved worldwide recognition. His professional career in mosquito abatement and related public health work began in 1908 and will be continued into his retirement, which, although not subject to schedule, will undoubtedly be characteristically active.

"Harold Farnsworth Gray, your mosquito abatement associates salute you!"

Harold Gray Day was really Monday, January 24 when tributes came from the opening address and concluded with a banquet appropriately honoring him. Dr. Lewis W. Hackett, worldwide authority on malaria control and member of the Alameda County Mosquito Abatement District Board of Directors, delivered a delightfully entertaining banquet address about him which brought out highlights of his life, both in factual account and anecdotal vein. Upon concluding, Dr. Hackett presented Harold with a beautiful leather-bound book entitled "Harold Farnsworth Gray, 1955" which contained approximately 100 letters from well-wishers lauding Harold for his outstanding career in mosquito control, and wishing him happiness and continued accomplishments in his impending retirement. American Association President Rowland E. Dorer presented Harold with an honorary membership in the American Mosquito Control Association. California Association President C. Donald Grant presented him with a companion honorary membership in the California Mosquito Control Association.

Presentations continued with a variety of gifts being placed before Harold and Mrs. Gray, the sum of which produced a warm and wholly appreciative glow as the accompanying picture illustrates. The gifts included a desk set consistent with the theme of the leather-bound book previously mentioned and included a leather-bound blotter pad, an onyx pen set centered with a barometer, a leather-bound dropover clock, an address book, letter opener, a leather-bound cigarette case with lighter, a beautiful silver tray, and last but not least, a "Texas fifth" of liquid hospitality contained within a decanter. These gifts were the result of voluntary contributions of nearly 100 well-wishing friends. Visibly touched and warmly happy over the entire matter, Harold delivered a short, heartfelt response. Yes, Harold Farnsworth Gray really had his day!—R.F.P.

JOINT CONFERENCE GUESTS VISITED CALIFORNIA SCENIC SPOTS AND MOSQUITO CONTROL AGENCIES ON THREE MOTORCADES

Following the joint conference, motorcades took off in three directions to visit scenic points of interest and representative mosquito control programs in California.

Dr. John N. Belkin served as host to a group of entomologists on a tour to various points of interest in the Mojave Desert area and which culminated in some ultra culicidology inspections of localities where a scarce genus of mosquito, *Uranotaenia,* is struggling for existence.

The next motorcade, led by Thomas D. Mulhern and Earl W. Mortenson, routed along the edge of the Mojave Desert, on to Bakersfield where Arthur F. Geib and Gordon F. Smith of the Kern Mosquito Abatement District explained their operational program. Next was a visit to the University of California—U. S. Public Health Service encephalitis research station at Bakersfield where Dr. Wm. C. Reeves and Dr. R. Edward Bellamy explained the research program under way in that area. This was followed by a tour along the Orange Belt Highway, ending with an inspection and explanation by Ted G. Raley of the Consolidated Mosquito Abatement District operations, headquar-

tered at Selma. A visit to Yosemite Valley, combined with a look at some of the giant redwoods, was followed by an inspection in Merced and an explanation by John Stivers of the Merced County Mosquito Abatement District program. This group then headed for the San Francisco-Bay Area and departed California by various routes.

The third motorcade, conducted by John R. Walker and Richard F. Peters, visited the attractive city of Santa Barbara, then followed the route up along the scenic rugged California coastline for several hundred miles until reaching the Monterey Peninsula, with visits to Carmel-by-the-Sea, Pacific Grove, and the city of Monterey. Next, Howard Greenfield and Jerry Lant of the Northern Salinas Valley Mosquito Abatement District, explained that district's program. This was followed by a swing through the Santa Cruz County redwoods en route to an inspection and narration by Edgar A. Smith, head of the Santa Clara County Vector Control Division, of their mosquito and fly control activities. The San Francisco-Bay Area then held the interest of this group until their subsequent departure for home.

All in all, everyone participating in these motorcades seemed to have an entirely happy and worthwhile experience.

SUMMARY OF REGISTRATIONS AT THE JOINT CONFERENCE OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION, INC., AND CALIFORNIA MOSQUITO CONTROL ASSOCIATION, INC., AT LOS ANGELES, CALIF., JANUARY 23–27, 1955.

Out-of-State Registrations: Canada, 2; Rockefeller Foundation, 3; Pan American Sanitary Bureau, 3; U. S. Public Health Service, 7; U. S. Dept. of Agriculture, 6; U. S. Armed Forces, 3; 15 states (exclusive of California) 61; total out-of-state registrations—85.

California Registrations: 6 institutions of learning, 9; 3 state agencies, 19; 6 city and/or county health departments, 10; 1 irrigation district, 1; 33 mosquito abatement districts, 103; 20 commercial firms, 27; total California registrations—169.

Total recorded registrations—254.

Total ladies' registrations—52.

NOTICE

The Proceedings of the 1954 Joint Meeting of the New Jersey Mosquito Extermination Association and the American Mosquito Control Association held in Atlantic City last year have now been printed and more than a thousand copies have been distributed. This volume contains 310 pages of excellent material that would make a valuable addition to any library on mosquito control work. Additional copies may be obtained from Dr. Bailey B. Pepper, N. J. Agricultural Experiment Station, New Brunswick, New Jersey.

Dr. Pepper and his associates who assisted in the compiling of the Proceedings are to be complimented on the excellence of the publication.

AMCA leaders and distinguished guests at the AMCA Toledo Seminar. Left to right, beginning in upper picture: President R. E. Dorer; National Advisor R. L. Vannote; Dr. P. Bruce Brockway, Director of Toledo Sanitary District; John D. Biggers, Chairman of the Board of Libbey-Owens-Ford; Grove Patterson, Editor of the *Toledo Blade;* Otto McFeely, AMCA Director for North Central District; and Lester W. Smith, AMCA Treasurer. (Photographs courtesy of Willys Motors.)

This *Fogs and Mists Seminar,* which was held September 29, 30 and October 1, 1954, was announced in the June, 1954 number (Vol. 14, No. 2) of *Mosquito News.* The program was printed in the September number (Vol. 14, No. 3) and an account of the meeting appeared in the December number (Vol. 14, No. 4). In the latter notice it was stated that the complete Proceedings would be published early in 1955. **The Proceedings are now available as promised,** in the form of a well printed 65-page booklet. This booklet contains not only the technical and operational papers that were presented, but also verbatim transcripts of the discussion (occasionally quite pointed and lively) which enlivened the proceedings. These papers and proceedings contain valuable information, not available elsewhere, which should be in the hands of anyone who is interested in fogging or mistblowing. Price $1.00, from P. Bruce Brockway, Jr., Superintendent, 5015 Stickney Ave., Toledo 12, Ohio.

NEWS AND NOTES

CHESTER ROBINSON, who has been Manager of the East Side Mosquito Abatement District at Modesto, California, for the past fifteen years, has been selected by the Board of Trustees to succeed to the managership of the Alameda County Mosquito Abatement District.

The Skeeter, news organ of the Virginia Mosquito Control Association, has a thought-provoking article on light traps, which is worthy of republication for those who may not have seen the original. In part, it says, "In 1954, the Bureau of Insect and Rodent Control continued to encourage mosquito commissions to maintain light traps in their districts, and offered the technical services of its personnel to identify and keep records of trap catches and to relay pertinent information to the men in the field. A single collector made daily rounds of 17 traps over a period of 18 weeks, records of each collection ordinarily being available by the end of the day it was received. 24,689 mosquitoes (were) processed, identified, and recorded during the 18 weeks period. 20,417 of this number were females, which gave an average figure of 9.53 per night (per trap), on the basis of all the traps operated.

"The *Mansonia perturbans* plague of spring and early summer was unusually severe at Virginia Beach during the past season and is especially exasperating to Supt. Carter because their breeding grounds in adjacent Seashore State Park remain inviolable by any except nature lovers with a horror of the successful operation of modern engineering conservation.

"The *Culex* family continues to rank high on the list, although its general prevalence decreased more than 30%; *Aedes vexans* and *P. confinnis* picked their spots to make vicious sneak attacks, although *vexans* did show a welcome decrease from the 1953 total. The rest of the 24,689 included most of the list of ordinary species commonly found in this area.

"The immediate value of such a trap program depends largely on the promptness with which pertinent information can be obtained and relayed to field directors. The cumulative value increases enormously as comparative figures become available over a longer period and a larger area. Richard F. Peters (commented) in March 1954, 'An important corollary to the growing mosquito problem is the need for measurement of mosquito occurrence in order to be able to depict accurately the trend and the success of the prevention or remedial program'."

A PREGNANT QUESTION FOR ALL CONTROL WORKERS, though couched in humorous vein, is also offered by the *Skeeter* in the same issue. Superintendent Carter, of the Virginia Beach area, quotes a four-year-old constituent as saying, "The mosquito men have been around, Grandpa. I smell 'em." The *Skeeter* comments, "Perhaps it would pay to publicize this identifying odor; or add a little popular perfume to glamorize our work with the ladies." (We assume that they mean to glamorize their "work," not their "work with the ladies,"—A. W. M.) "How about trying a touch of 'My Sin'?" the *Skeeter* adds. "Any suggestions?"

MILTON H. BUEHLER, of the Lane County Health Department, Eugene, Oregon, sends in as a scientific note, a "Preliminary Report on a Recently Developed Thermal Fog Generator."

"A large capacity thermal fog generator has been developed by the Mosquito Control Section of the Lane County Health Department, in Eugene, Oregon. This equipment is a modification of the Plumber's Nightmare, King Size, (T. G. Raley, *Mosquito News,* 12(3):141–144). It has a capacity of 52 g.p.h., produces a uniform fog, and has proven effective in the field for the reduction of mosquitoes at distances of one mile under all normal weather conditions.

"This piece of equipment is powered by a 6 h.p. Wisconsin air cooled motor which is connected by belt drive to a high pressure blower and two Bendix gear type pumps. The blower has a six inch inlet and outlet, turns at 6,000 r.p.m. and delivers air at the rate of 600 c.f.m. The air passes through a jacketed fire pot where the air is heated. Heat is provided by burning kerosene, atomized by a 3 g.p.h. Monarch oil burner nozzle at a pressure of 250 p.s.i. supplied by one of the Bendix gear type pumps having a capacity of 1 g.p.m. at 1,000 p.s.i. from a 15 gallon kerosene storage tank. Heated air from the fire pot passes into a Venturi type fog tube consisting of a 3" pipe tee reduced to 1¼" by a short nipple and then enlarged to 4" by a two foot length of steel irrigation tubing, the opening of the 4" pipe is again reduced to 2½". Fog oil, a 10% DDT–S/V Sovacide F solution, is atomized into the fog tube by means of an atomizing nozzle (Spraying Systems Co. Nozzle No. ¼ LNNSS26) inserted in a plug, fitting into the 3" tee, at the rate of 52 g.p.h. at a pressure of 125–150 p.s.i. by one of the Bendix gear type pumps having a capacity of 1 g.p.m. at 1,000 p.s.i. from a 160 gallon oil storage tank mounted on a two-wheeled trailer.

"A uniform fog is obtained by regulating the pressure of the kerosene burner nozzle and the fog oil nozzle. Slight adjustments in pressure enable the operator to compensate for temperature and humidity changes in the atmosphere, which have an effect upon the dispersal and drift of aerosol fogs.

"During the 1954 mosquito control season it was possible to operate this piece of equipment every night throughout the season regardless of weather conditions. Effective mosquito control was obtained at distances of one mile. Approxi-

mately one township, 36 square miles, was fogged each night. Arrangements have been made with the U. S. Department of Agriculture, Agriculture Research Service, Entomology Research Branch, Insects Affecting Man and Animals, Corvallis, Oregon, to run a series of tests on this equipment to determine the average particle size, effective killing range, and the amount of thermal decomposition of DDT. A more detailed report will be submitted following the completion of these tests."—Milton H. Buehler.

Oscar V. Lopp, who recently accepted the position of Entomologist for the South Cook County Mosquito Abatement District, in Illinois, writes that their plans for the 1955 season are already nearing final form and he extends an invitation to visit their activity and to see their operations, if by chance members of other areas can get away from their own problems long enough during the season to pass by Chicago.

Harry Stage, too busy to write a letter, sends the agenda of the Malaria Conference for Western Pacific and South East Asia Regions, held 15 to 27 November 1954, in Baguio, Luzon, the Philippines. For those who have never been to the Philippines, Baguio is a mile-high mountain city, whose clear, cool air offers an almost too-chilly relief to sweltering lowlanders, who have to play golf to keep warm. Harry adds the note, "This Baguio place, after a year in the heated lowlands is a real honey. I'm enjoying it no end. After the conclusion of this interlude, a group of five Vietnamese and I shall go around the Philippines and Taiwan in an effort to find training facilities for our own nationals. Regards to all, Harry."

The list of participants includes such well-known people as Dr. Luang Ayurakit Kosol, of Thailand, for whom the late Deed Thurman named a new genus of Thai mosquitoes, Francisco Baisas, of the Philippines, Dr. Robert H. Black of Australia, Dr. Antonio Ejercito, of the Philippines, Professor Kaoru Morishita, of Osaka University, Japan, Dr. H. de Rook, of Netherlands New Guinea, Travis E. McNeel, of FOA, the Philippines, Dr. Paul Russell, of Rockefeller Foundation, Dr. G. R. Villanueva, of the Philippines, Dr. Francisco Dy, of the Philippines, Don J. Pletsch, of WHO, Taiwan, and many others, including Harry and his associate Dr. M. E. Farinaud.

Lawrence B. Hall, in charge of equipment development for the Savannah laboratories of the U. S. Public Health Service's Communicable Disease Center, departed on January 19 for Geneva, Switzerland, where he will serve for six months as a consultant to the Expert Committee on Insecticides of the World Health Organization. Larry's previous assignments have taken him to such far and near places as China (1941–2), Bombay and Karachi, India (1942–3), Atlanta, Ga. (1943–49), Tehran, Iran (1949) and finally back to Savannah. While on his assignment to Geneva, he will replace temporarily Mr. J. W. Wright, the Secretary of the Expert Committee, while Mr. Wright is attending graduate school at the University of Minnesota.

Mr. William J. Buchanan has been announced as the new Engineer-Manager of the South Cook County Mosquito Abatement District. In addition to serving some six years as a sanitary engineer in the Medical Service Corps of the Army, during World War II and the Korean war, leaving active duty with the rank of Lt. Colonel, Mr. Buchanan has served as advisor in North and Central Viet Nam and at home, with the U. S. Public Health Service, in Indiana, Mississippi, South Carolina and California. He has been in charge of shoreline improvement at all TVA reservoirs and was chairman of the Work Group on Mosquito Control and Allied Problems of the Arkansas-White-Red River Basin Inter-Agency Committee, immediately prior to accepting the position in Illinois.

William C. Frohne, Who Sent in a Note on the Alaskan *Aedes* Species Infested with Mermithid Worms, to supplement the article by Jenkins and West in the September *Mosquito News,* sends the following supplemental note on a species not yet listed for these parasites:

"(3) One mermithid in a 4th instar *Aedes excrucians* (Wlk.) collected 19 May 1954 from a semi-permanent *Carex* pond near Copper Center, Alaska. From this same pond 6 other entirely unparasitized collections were made in May and June 1953 and 1954. The pond is intermediate in type so that 6 species of *Aedes,* one each of *Culex, Anopheles,* and *Culiseta* breed there before it dries up late in July."

California Vector Views in an article by Tommy Mulhern, reports that the East Side Mosquito Abatement District, in cooperation with the Modesto Irrigation District, has been successful in installing more than 100 pumps at strategic collection points where excess irrigation water can be safely and economically returned to the canals for reuse. Seventeen agencies have cooperated in the formation of a water conservation committee which is trying, through voluntary modification of individual programs, to develop water resources to optimum condition with no conflict among the various interests. "With estimates of a doubled population in the State for 25 years," the report goes on to say, "irrigation will have to be expanded from 7 to 17 million acres to provide the necessary food."

In San Joaquin County, California, meanwhile, the Board of Supervisors has, after 6 years of effort on the part of civic groups, authorized the formation of a mosquito abatement district. This district, of approximately 1,000 square miles, will include Tracy, Stockton, Manteca, Escalon, Farmington, and Ripon. Present plans call for operations to begin on July 1. The Northern San Joaquin County Mosquito Abatement District,

formed in January 1948, was scheduled to annex some 200 square miles prior to November 15.

S. F. BAILEY, R. M. BOHART AND L. J. BOOHER have combined in the production of an excellently-written and illustrated pamphlet entitled, "Mosquito Control on the Farm," issued as Circular 439, by the University of California. The booklet contains 28 pages and is filled with sound guidance in water and land management, and the most effective methods of mosquito inhibition and control. It may be obtained without charge.

WHO'S WHO IN A.M.C.A. LEADS US TO FOUR WELL-KNOWN MEMBERS FROM OUTSIDE THE UNITED STATES. DR. H. DE ROOK, for thirty years with the Public Health Service of the Netherlands East Indies, and since 1948, chief malariologist of the Netherlands New Guinea oil companies is located at Sorong, Netherlands New Guinea.

DR. ABDUL RAHIM, of Shahre Nai, Kabul, Afghanistan, has for the past five years been Director General of the Malaria Organization of Afghanistan. As might be expected of one living in that country, he admits he is a passionate hunter. Dr. Rahim was born in 1909 in Quetta and graduated from high school in Germany, after which he attended Friedrich Wilhelm University in Berlin and received his doctor's degree in 1939. Dr. Rahim organized and headed the Malaria Organization of Afghanistan, which has trained its own personnel and has continuously expanded operations until, at the end of 1953, nearly 1,000,000 persons were being protected.

DR. CECIL R. TWINN, well known as an entomologist of the Canadian Department of Agriculture, in charge of the Veterinary and Medical Entomology Unit of the Division of Entomology, has had a past history which we do not all know. Born in London, England, he migrated to the U. S. in the spring of 1914 but left to enter Canada at the outbreak of the war in order to join the Canadian Army. He received his B.S. from the University of Toronto in 1922, his M.S. from McGill and Ph.D. from Ottawa. Besides having been the president of the American Mosquito Control Association, he is also a past president of the Professional Institute of Public Science of Canada, a Fellow of the Royal Entomological Society of London, and a member of the Entomological Society of America, the Entomological Society of Canada, the Entomological Society of Ontario, the Agricultural Institute of Canada, and an honorary member of the Canadian Pest Control Operators' Association.

DR. LUIS VARGAS, head of the Institute of Health and Tropical Diseases in Mexico, D.F., who received his M.D. from the University of Mexico and Master of Public Health and of Biological Science from Johns Hopkins and Mexico, respectively, is also a member of many important scientific organizations, including the National Academy of Sciences of Mexico and the W.H.O. Malaria Experts, Parasitic Diseases Experts and Insecticides Committees. From the National Academy of Sciences he received the Carnot Prize in 1952.

THE EIGHTH ANNUAL MEETING OF THE VIRGINIA MOSQUITO CONTROL ASSOCIATION was held on February 24 at the Monticello Hotel in Norfolk, Va. The Association, which has a membership of about 272, had an attendance at the meeting which was somewhat in excess of the 110 who registered. Members of the A.M.C.A. attended from New Jersey (Bob Vannote, Lester Smith and Dan Jobbins), from Washington, D. C., (W. C. McDuffie) and from North Carolina (Charles M. White) and there were representatives of the Navy, the Army Corps of Engineers and the 15 mosquito control districts of Virginia. A very full and well rounded program was presented during the two sessions, which included papers on local problems, new insecticides, species evaluation, the importance of training and of specialist supervision, the continuing value of basic permanent-type control and the need to utilize proper mechanical equipment in the face of present-day increased labor costs and decreased diligence. Mr. William S. Coburn, City Manager of Hampton, Va., who testified to the importance of mosquito control in his part of what has become the largest metropolitan area in Virginia and one of the largest concentrations of military installations in the world, added a thought which found favor with all. He asserted that while Rollie Dorer had attempted to teach him the difference between *Anopheles* and other long-name species, he felt that they all belonged in a super-genus *Mephistopheles*. Mrs. L. Crawford Syer, a grand-niece of Dr. Carter, late Surgeon-General of the U.S.P.H.S. and a famed mosquito fighter, told of her community's successful efforts to arouse interest in formation of a mosquito-control district. She also reminisced of the tale, which she remembered in her childhood hearing her granduncle tell, of his use of cows to protect the embarking troops of World War I at Hampton. Seems he drove the cows in between the troops and the mosquitoes with the predictable but nonetheless highly satisfying result that the troops were left much more alone. The address at luncheon was by Dr. Edward H. Jones, pastor of the First Presbyterian Church of Norfolk, who told of his chaplain days in Alaska during W.W. II and the interest there in mosquito control, and then spoke movingly and effectively on Brotherhood Week, saying that mosquito control was one evidence of brotherhood in action but pointing out that in general ethics have lagged far behind science in the rush of progress.

RALPH C. BARNES, who has been entomologist with the Insect and Rodent Control Section, Chief of the Insect and Rodent Control Section and lately Chief of the Field Training Section of the U.S.P.H.S. Communicable Disease Center in Atlanta, Ga., has been announced as an Assistant

Chief of the Center's Training Branch. In his new assignment, Mr. Barnes will take charge of the nationwide training facilities of the Branch.

Three New Mosquito Abatement Districts Have Been Formed in the Chicago Area within the last two years. The possibility of forming other new districts is evidenced by the many requests for information received by the Des Plaines Valley Mosquito Abatement District.

The Lake Bluff District has been in active operation for the past two years. Its boundaries coincide with those of the Village of Lake Bluff and adjoin the Lake Forest District to the south. Dr. Robert L. Woolridge is President of the Board of Trustees and Mr. Thomas J. Evert is Superintendent.

The Glen Ellyn District in DuPage County was established in July, 1954, and will begin field operations in the near future. The district includes the Village of Glen Ellyn and some adjoining areas, approximately six square miles. Mr. Willis Collins is President of the Board of Trustees.

The South Cook County District, established in 1952, has finally disposed of all litigation and is now making plans for operation early in 1955. This district of approximately 360 square miles with a population in excess of 500,000 includes all of Cook County south of 87th Street, and adjoins the southern boundary of the Des Plaines Valley District. Dr. Edward J. Czarnetsky is President and Mr. William J. Buchanan, Engineer-Manager.

From the Report of the First Mosquito Control Conference in the State of Oregon held in Division of Sanitation and Engineering, Oregon State Board of Health, Portland, Oregon, December 15, 1954. (Members of the Oregon State Board of Health, assisted by many other vector control workers in the state, planned and conducted the conference):—

Verne C. Reierson, Chief, General Sanitation Section, acted as chairman for the opening program. The opening address was given by Curtiss M. Everts, Jr., Director, Division of Sanitation and Engineering. Mr. Everts outlined the trend of vector control requirements that have been made during the past several years. He noted specifically the mosquito control work, as well as other insect control, will continue to be an increasing problem in Oregon for a number of reasons known to everyone in attendance. Everts also commented on the basic needs for planning and conducting workmanlike vector control programs. One of his points was the need to provide more workable legislative statutes that would be feasible so that requirements of all the areas within the state could be administered under a satisfactory local administration. Mr. Everts welcomed all persons in attendance on behalf of the Oregon State Board of Health and endorsed the proposed principles of planning for and developing an association that would be singly concerned with vector control activity.

Dr. Ralph R. Sullivan, Director, Industrial Hygiene Section, Oregon State Board of Health, led a discussion on insecticides, their use and limitations. Dr. Sullivan presented to all persons in attendance a brochure of materials which included identification of pesticides, trade names of organic phosphorus insecticides, toxicology of agricultural chemicals used as pesticides (with particular reference to precautionary measures against organic phosphorus poisoning), respiratory devices for protection against inhalation hazards of dusts, mists and low vapor concentrations of certain pesticides. Sullivan pointed out the problem of proper labeling of insecticides confronting the public agencies. A review of the action covering registration of economic poisons by the State Department of Agriculture was given. Dr. Upholt, as well as Mr. Eddy, contributed significant points in response to the questions and comments presented by the group. It was agreed that any individual working for a public agency should utilize only those insecticides that are well-established to the industry both from the laboratory and research areas, as well as actual field use. The trend turning toward what might seem more effective and dramatic chemicals should be tempered in the light of the unknown, particularly if there is a greater known hazard in either handling or applying those chemicals.

Mr. Noel P. McKeehan acted as chairman of the following portion of the program, which included a mosquito control program report, given by Mr. John Huber, of the Department of Insect Control, City of Portland; a paper on the historical background of the mosquito control program leading up to the 1954 report, by Mr. Milton H. Buehler, Director of the Lane County Mosquito Control Program; an outline of the activities of the Douglas County mosquito control program by Mr. LaVerne S. Miller, Sanitarian; an outline of the proposed program for the Coos County area commencing next year, by Mr. C. E. Fields, Sanitarian; an outline of the present city-wide program as now conducted, by Mr. W. G. Hellie, Entomologist and Sanitarian, City of Salem, Marion County Health Department; and an outline of the problems and the need for a mosquito control work in Columbia County, by Mr. Bennie Rinehart, Sanitarian.

Mr. Milton H. Buehler was the moderator of a panel to discuss and answer questions on mosquito control programs and problems.

Mr. Reierson acted as temporary chairman of an organizational session. Persons in attendance selected Milton H. Buehler as chairman and he in turn appointed Mr. John Huber and Mr. LaVerne S. Miller to work with him as a committee with all of the necessary privileges to make studies and appointments and to plan for the next meeting at which time a definite set of recommendations will be presented for action to indicate the title, purpose and objectives of said association. It was also unanimously agreed that Mr. Buehler would act as a representative

from this group at the forthcoming American Mosquito Control Association meeting to be held in Los Angeles, January 24–27, 1955.

THE UTAH MOSQUITO ABATEMENT ASSOCIATION held its 8th annual meeting on March 18 and 19, in Farmington, Utah. The program included a panel discussion featuring members of the U.S.P.H.S. field station at Logan, where Archie Hess is now Chief; a report from Dick Peters, President of the AMCA, on the joint conference of the AMCA and CMCA held at Los Angeles in February; reports and papers from California mosquito control men; reports and papers from Utah mosquito control men on problems of special interest in Utah; and individual reports which were headed "Highlights of the Districts," from the various Utah mosquito abatement districts. (Notes made by the Editor from an advance program contributed by Don Rees.)

A GROUP OF PEOPLE INTERESTED IN FORMING A NEW ENGLAND MOSQUITO CONTROL ASSOCIATION met at the University of Massachusetts on February 2 and 3. The meeting promptly revised the territory to include New York State and adopted the name Northeastern Mosquito Control Association. The purpose of this association is to promote the efficiency of mosquito control and related activities through the encouragement of research, development of procedure and the interchange of information. They hammered out a constitution and bylaws and elected a slate of officers, as follows:

President—Joseph F. Pannone, Mosquito Control Supervisor, Dept. of Agric., Veterans Memorial Bldg., 83 Park St., Providence, R. I.

Vice President—Lewis F. Wells, Supt., So. Shore Mosquito Control Project, 1120 Hancock St., Quincy, Mass.

Secretary-Treasurer—Robert L. Armstrong, Supt., E. Middlesex Mosquito Control Proj., 301 City Hall, Cambridge, Mass.

Member for one year—Frank Shaw, Associate Professor of Entomology, Fernald Hall, Univ. of Mass., Amherst, Mass.

Member for two years—Patrick Tocci, Needham Public Works Dept., res.—285 Central Ave., Needham, Mass.

These five officers constitute the Executive Board. There will be an Advisory Committee made up of one member from each State in the area included in the Association.

Main features of the meeting in addition to the business of organizing were (1) an account of blackfly control in New York State by Dr. Hugo

Officers of the newly formed Northeastern Mosquito Control Association. Left to right: Patrick Tocci, Frank Shaw, Joseph Pannone, Robert L. Armstrong and Lewis F. Wells.

Jamnback, (2) a panel discussion on prehatch insecticide applications for mosquito control, (3) attendance as guests of the Eastern Conference of the National Pest Control Assn. during the session on insecticides and (4) a panel on supplementary nuisance pests: Greenheads, biting gnats and midges. At the evening session Prof. Charles P. Alexander told of his observations in the Territory of Alaska and showed many beautiful color photos, taken during the several journeys which he and Mrs. Alexander have made in that territory.—R. L. Armstrong.

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